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EFFECTIVE MILITARY INNOVATION: TECHNOLOGICAL AND ORGANIZATIONAL DIMENSIONS

by

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The subject of military innovation is very popular in the United States military today. Innovation is encouraged and fostered in all branches of the service. This thesis takes a step back from specific developments today and looks at modes of innovation. The different forms of innovation explored are technological innovation, i.e. introducing weapons, transportation and/or information technology into the battlefield; organizational innovation, i.e. changing how different pieces of the military relate to each other; and the combination of both technological and organizational innovation. Through a series of historical case studies, this thesis shows that militaries that have innovated only by means of adding new technology have not been very successful in the past. It also shows that militaries that innovate only organizationally often make the changes necessary to develop new concepts of operations and tactics and increase their effectiveness. However, this thesis also finds that innovating both organizationally and technologically is historically the most promising approach, in terms of increasing military power and effectiveness.

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EFFECTIVE MILITARY INNOVATION: TECHNOLOGICAL AND ORGANIZATIONAL DIMENSIONS

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ABSTRACT

The subject of military innovation is very popular in the United States military today. Innovation is encouraged and fostered in all branches of the service. This thesis takes a step back from specific developments today and looks at modes of innovation. The different forms of innovation explored are technological innovation, i.e. introducing weapons, transportation and/or information technology into the battlefield; organizational innovation, i.e. changing how different pieces of the military relate to each other; and the combination of both technological and organizational innovation. Through a series of historical case studies, this thesis shows that militaries that have innovated only by means of adding new technology have not been very successful in the past. It also shows that militaries that innovate only organizationally often make the changes necessary to develop new concepts of operations and tactics and increase their effectiveness. However, this thesis also finds that innovating both organizationally and technologically is historically the most promising approach, in terms of increasing military power and effectiveness.

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I. INTRODUCTION

The United States Department of Defense is itching for change. The signs of this unease are numerous. There exists a newly created Department of Defense Office of Force Transformation. The United States Navy has established an "Outliers" work group for unconventional strategic thinkers. Rumors of a Revolution in Military Affairs rush around the hallways of the Pentagon and retired officers write books about The Future of Warfare. The United States Army has transferred their energies to Force XXI and the United States Navy redesigns a new class of ship and a new class of submarine almost every year. This itch for change could be a sign of the times; times where information technology develops a generation in a year and a half and computers over five years old are antiquated. On the civilian side of the world, bookstores are littered with non-fiction entitled Leading Change, The Change Management Toolkit, Managing Transitions: Making the Most of Change and Leading in a Culture of Change. Clearly, change is in.

McKinsey analysts Richard Foster and Sarah Kaplan claim that businesses that fail to embrace change and fail to evolve with current markets are doomed to failure.[1] Similarly, a military that fails to innovate when their contemporaries are innovating is doomed. So the quest for change within militaries is a rational and hopefully encouraged behavior. This thesis will look at how different militaries approach change and evaluate their successes and failures. If it is true that change is the only constant, then it makes sense to have the most effective changes possible.

Businesses today describe innovation as a multi-faceted organism, and perhaps a bit too broadly, allowing the term to be applied to "new distribution systems, customer service, marketing or financial services", according to Joyce Wycoff, founder and executive director of the Innovation Network.[2] Each of these innovations can be tweaked on a daily basis in the open market to maximize profit potential. In militaries, innovation is more constrained. Unlike most businesses, a military's strategy, operations and tactics are rarely tested in open battle. This means that while businesses compete every day to

[1] Richard Foster and Sarah Kaplan, Creative Destruction (New York: Doubleday & Company, Inc, 2001) 14.

[2] Joyce Wycoff, "Defining Innovation," ON Business 1 January 2001 http://www.onbusiness.net/articles_html/JoyceWycoff_224.html (25 May 2002).

make a profit, militaries must wait for an international conflict to fine-tune their strategies and see if they work outside of limited exercises.

The military philosopher Friedrich von Bernhardi claims that each war and every military conflict has its own distinct characteristics and that it is vital to understand as many ramifications surrounding the conflict as possible. While it is important to study recent military history and learn from successes and mistakes made in the past, one can rest assured that the next conflict will not be the same as the previous conflict.[3] Since the nature of war is always changing, it is important to look ahead towards new developments and create new ideas and principles according to modern requirements. According to von Bernhardi, the factors that contribute to military superiority are numerous: strategic, tactical, quality of commander, numerical advantage, changes in technology and correct application of those changes are all contributors. It is important for a military to advance with the changes instead of staying in the past.

There are, according to Von Bernhardi, a few constants in the nature of war. The object of war is always to impose one's will upon the enemy and militaries can act either offensively or defensively to do so. The human factor will always play a role in warfare and individuals or groups can be manipulated to influence the course of war. Other than those few broad constants, warfare is a constantly changing art. It becomes dangerous to create rules of war from previous battles as opposed to general lessons of war. History is always seen through a filter that is biased with the opinions of the victors and historians of the times. So the best militaries can do is make educated guesses during the intermediary periods as to what may or may not be successful in future conflicts.[4]

The options open to militaries to evolve and prepare themselves for the next conflict are limited: militaries can either change how they do business or change what they do business with. In this thesis, these options will be called organizational innovation and technological innovation.

Technological innovation is easy to understand, but difficult to define. The Organization for Economic Cooperation and Development published the Oslo Manual to define innovation for the purposes of collecting data and further study. Technological

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[3] Friedrich von Bernhardi, On War of Today (London: H. Rees, ltd, 1913) 55.

[4] Bernhardi, 48-63.

innovation is defined in two parts: technological product and technological process innovation. This thesis will use the manual's definition for technological product innovation: "A technologically new product is a product whose technical characteristics or intended uses differs significantly from those of previously produced products. Such innovations can involve radically new technologies, can be based on combining existing technologies in new uses, or can be derived from the use of new knowledge."[5] In layman's terms, it is the latest "gee-whiz" toy that the military-industrial complex has developed. It is the tank, machine gun, Stealth bomber, Tomahawk missile, and GPS receivers that fascinate the military. In this thesis, technological innovation will be divided into three categories: weapon technology, transportation technology and information technology. Weapon technologies are the actual weapons deployed, whereas transportation technologies are the platforms that weapons are carried on, such as ships, tanks and aircraft. Information technology allows for both information gathering through sensors and satellites and communication through radios, Internet and telephony.

Organizational innovation redefines how the military does business. Joyce Wycoff defines organizational innovation as intended change. Innovation is a three piece definition: "having a common direction or vision, recognizing and deciding on opportunities related to the vision and intentionally and effectively moving in a direction to achieve the objective".[6] Stephen Peter Rosen, professor of National Security and Military Affairs at Harvard, bends this general framework into a military context. He defines a major military innovation as "a change that forces one of the primary combat arms of a service to change its concepts of operations and its relation to other combat arms, and to abandon or downgrade traditional missions. Such innovations involve a new way of war, with new ideas of how the components of the organization relate to each other and to the enemy, and new operational procedures conforming to those ideas. They involve changes in critical tasks, the tasks around which warplans revolve."[7] Both of these definitions leave open the possibility of introducing new technology as a type of

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[5] Organization for Economic Cooperation and Development, Oslo Manual (Eurostat: European Commision, 1996) 33.

[6] Wycoff, 1.

[7] S.P. Rosen, "New Ways of War: Understanding Military Innovation," International Security Summer 1988: 134.

innovation. Organizational innovation as it is defined for the purpose of this thesis will consider the introduction of new technology into organizational innovation as a third type of innovation separate from purely organizational innovation.

In this thesis, an organizational innovation will be defined as an innovation where one of the primary combat arms of a service adopts new ideas about how the components of the organization relate to each other and to the enemy, abandoning or downgrading traditional missions. Organizational innovation involves recognizing and deciding on new critical tasks. Some organizational innovations that will be explored in this thesis include the Boer Commandos during the Boer War, the Royal Navy's decision to adopt convoying during WWI and Ludendorff's storm-troop squads during WWI. What all of these organizational innovations have in common is that new war-fighting capabilities were introduced simply by reorganizing the manner in which the forces related to each other and how technology was used. Organizational innovation may not involve any new technology at all. It simply makes the most effective use of what is available.

Finally, militaries can use a combination of both organizational and technological innovation. This is a risky proposition, allowing national interests to depend on untested technology and organizations; however, it also has the potential for the greatest returns. Ideally, the technological and organizational innovations will support and enhance each other, contributing a much more effective military force. A force truly dedicated to rebuilding and strengthening itself, as the German military was during the interwar periods of the 1920's and 1930's, may take advantage of this combination of both types of innovation.

This thesis will examine case studies of militaries that have attempted all three of these methods of innovation. Chapter II will examine militaries that innovated technologically, Chapter III will examine militaries that innovated organizationally and Chapter IV will examine militaries that innovated both technologically and organizationally. Each case study will look at the development of the technology and/or organization in a specific military and that military's effectiveness in the next armed conflict or some other test of its success. In each chapter, failures and success stories will be examined and analyzed. These questions will be asked: Is this a successful method of

innovation? Why did a method fail if it worked for so many other militaries? Why did a method succeed when it failed so many other nations? What makes this a successful form of innovation? In this manner, the value of each method will be measured.

This begs the question of how effectiveness or success will be measured in this thesis. Allan R. Millett, Williamson Murray and Kenneth N. Watman define "a fully effective military is one that derives maximum combat power from the resources physically and politically available".[8] While it is impossible to know whether maximum combat power has been derived from a specific innovation, it is easy to gage whether an innovation has significantly improved combat power. In this thesis, a new technological innovation will be considered effective if it yields more positive results than could have been achieved with older, more traditional technology. A new organization is effective if it yields more results than older organizations had yielded. The German panzer divisions will be considered effective in this thesis because they captured a territory in weeks that Germany had failed to capture in four years during WWI. Military effectiveness in this thesis is measured in territories gained or controlled, convoys that survive or sink, targets hit or supplies lost.

Several cases, such as the German armored division during WWII, the German u-boat command during WWII and Commando military operations during the Boer War will be declared successful even though the militaries ultimately lost the conflict they were engaged in. Victory is a combination of many factors: politics, military strategy, economic strength and natural resources are only a few of a long list that is not solely dependant on military effectiveness. For example, the Chiapas movement in Mexico has won significant concessions from the Mexican government, despite the fact that the activists were devastated in their only major military action. This thesis ignores political ramifications of military success and other issues that contribute to international affairs and instead focuses on a small part of what contributes to victory: military innovation.

The goal of this thesis is focus more clearly on how militaries choose to innovate or not to innovate their technologies and their organizations. Innovation is not something to be approached haphazardly and without strategy. Chris Hables Gray claims that militaries have historically attempted to make war better through a variety of efforts and

[8] Allan R. Millett, Williamson Murray and Kenneth N. Watman, "The Effectiveness of Military Organizations" International Security Summer 1986: 37.

have consistently failed, only making it more costly in terms of economic and human capital.[9] Part of this is due to an unprincipled approach to innovation; pulling the newest weapons and the most popular, jargon riddled organizational concepts off the shelf. Innovation needs to be approached with care and consistency. As this chapter is being written, Secretary of Defense Donald Rumsfeld is testifying to Congress about why he wants to end funding for the Crusader Artillery System. Secretary Rumsfeld maintains that his decision to cut funding "is about foregoing a system originally designed for a different strategic context to make room more promising technologies that can accelerate transformation."[10] His point is that this particular technological innovation does not match the organizational innovation that the military is pursuing. A consistent strategy is important.

This thesis is taking one step further back than SECDEF Rumsfeld and asks the following question: how should one pursue innovation? Yes, it is important to be consistent, but are we consistently pursuing the most effective methods of innovation? Should one pursue the newest technology? Should a military try the most modern organizational innovations? Is a combination of both the best answer? These are the questions that this thesis will attempt to answer.

[9] Chris Hables Gray, Postmodern War (New York: The Guilford Press, 1997) 3-4.

[10] Donald Rumsfeld SECDEF, Testimony to Senate Armed Services Committee 16 May 2002 http://www.cnn.com/2002/ALLPOLITICS/05/16/rumsfeld.crusader.reut/index.html (16 May 2002).

II. TECHNOLOGICAL INNOVATION

A. INTRODUCTION

Pursuing technological innovation is the most common way militaries try to improve their effectiveness. Having the largest, fastest, most powerful weapon around gives a distinct advantage to the owner. Militaries that focus on this form of innovation are convinced that science holds the answers to any obstacles that are created, if only the right bits of scientific information can be put together. Maj Gen J.F.C. Fuller, Royal Army is quoted as saying that "Tools or weapons, if only the right ones can be discovered, form 99 percent of victory. . . . strategy, command, leadership, courage, discipline, supply, organization and all the moral and physical paraphernalia of war are as nothing to a high superiority of weapons—at most they go to form the one percent which makes the whole possible."[11]

The American military in particular is enamored with this approach. According to Chris Hables Gray, Americans adopted their love of technology because of the victories they attributed to it during the Second World War. The science and technology that built the atomic bomb, designed the firestorms of Dresden and Tokyo, and built aircraft carriers were the true victors of the war in the eyes of policy makers. This was the opinion of the military elite and those who helped determine and shape much of U.S. military policy in the post war era.[12]

This chapter will examine several cases of militaries that have innovated by adding new and improved weaponry into their arsenals. Specifically, it will examine militaries that have attempted to innovate exclusively with new technology and ignored organizational innovation to support their new acquisitions. Technology on the battlefield can broadly be divided into three groups: weapons, transportation and information systems technology. Cases of militaries that have invested in all three forms of technology will be examined. The incorporation of the machine gun into the British army and the German army's use of chemical weapons during WWI will be discussed as

[11] Chris Hables Gray, Postmodern War (New York: The Guilford Press, 1997) 107.

[12] Gray, 70-82.

examples of technologically innovative new weapons. The Confederate Army's use of the railraod during the interwar period will be examined as an example of transportation technology. The British navy's incorporation of radio during the battle of Jutland and the recent U.S. Army experiments with a digitized force (Force XXI) will be examined as case studies of militaries using new information technologies.

These cases have been selected to look at different militaries and types of technological innovation over the last century. They illustrate militaries that have fit new technologies into their existing organizations or sometimes have reverted to older and more outdated organizations as opposed to revising them to fit the new technologies. The research and development costs of new technology are high, and only a few economically powerful nation states have found it beneficial to subsidize such extensive research. So the militaries examined are similar in that they belong to large, powerful nations such as Germany, the United States, and England.

Arthur C. Clarke wrote a short story entitled "Superiority" in which the narrator blames his nation's recent loss in war on their over-confidence in weapons that were not yet perfected. The losing military was betrayed by three different technologies. The first was a sphere of annihilation that would destroy everything in a given radius around it. This weapon had to be deployed as a missile to avoid destroying friendly forces. Inspired by successful results in the laboratory, the military immediately converted its entire missile launching capability to use this new weapon. This required some redesign and development of current missiles, which could not safely operate with the sphere of annihilation. This refitting of missiles took a year, during which time the enemy had feverishly built a large fleet of less advanced ships and won the next few engagements because of the sheer size of their forces.

The next technological innovation introduced into the fictional military was the Battle Analyzer, which would scientifically determine the most efficient course of action. Unfortunately, the training for operators of this information technology was difficult and only two analyzers could be fully staffed. Because of the size of the equipment, it was carried on an unarmed cruise-liner. The enemy soon discovered that the unarmed cruisers were a critical vulnerability and attacked. The nations' forces had to retreat as

they no longer had a capability to organize the engagement. The Battle Analyzer was the penultimate information system.

The final technological innovation introduced was the Exponential Field, which camouflaged ships from the enemy by distorting the space-time continuum. As the exponential field affected the location of the ships with respect to enemy ships, it can be viewed as a transportation technology. Unfortunately the Exponential Field left ships without communications or effective navigation equipment and the ships were forced to retreat. The implied warning is that technology is fallible.[13] It is also interesting to note that the author divided his technologies into three categories: weapons, transportation and information.

B. WEAPONS TECHNOLOGY

Militaries that are enamored of innovating by adding new technologies into their arsenals are often motivated by examples of smaller, technologically advanced militaries that have defeated larger forces which were using relatively rudimentary technologies. The innovators are captivated by the idea that a few men with advanced weapons can defeat an enemy ten times their size. This idea is clearly demonstrated in the British army's use of the machine gun to colonize Africa.

The machine gun captured the popular imagination during the European colonization of Africa during the late 1800's. The Gatling gun, one of the first machine guns, was a remarkable improvement over previous weapons. The first Gatlings made in 1862 fired 100 rounds per minute, while later models twenty years later could fire 1,000 rounds a minute.[14] The rate of fire of the rifle musket, the primary infantry weapon at the time, was three rounds per minute under live fire, and slightly better in an ideal situation.[15] The British colonial campaigns in Africa are particularly good examples of the potency of this new weapon. Because colonial wars were considered secondary wars

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[13] Arthur C. Clark, "Superiority" (New York: Fantasy House Inc., 1951) 351-359.

[14] Mollie Gilbert, "Ahead of its Time: The Gatling Gun and the Reconstruction" 31 January 2001 http://www.columbia.edu/~mrg24/warfare.html (6 March 2002.). Gilbert also notes a reluctance to use machine guns on the part of military commanders because they felt that the weapon challenged their honor, patriotism, courage and virtue.

[15] Daniel Commins, "Frontiers: The Machine Gun" 30 November 2001 http://www.geocities.com/dencee/Before.htm (15 March 2002).

by British military leadership, limited numbers of troops were sent to the area. The small scale of the conflict meant that most wars were a series of skirmishes. This case will examine the role of the machine gun in the Battle of Ulundi during the Anglo-Zulu War (1879), the battle of Tel-el-Kebir (1882) during the Sudan Wars and a brief skirmish in Transvaal (1896) that was one of the catalysts of the Boer War.

In 1879, British forces were engaged in Zululand. The machine gun was fully adopted by the British navy, but not yet by the army. The initial British force of 13,200 men was virtually annihilated by a force of over 40,000 Zulu warriors who used swarming tactics and the element of surprise. After the British army reinforced to the size of 4,300 men and two Gatling machine guns, the fortunes of the militaries were reversed.

The Gatling machine guns were manned by a naval battalion and under control of a midshipman, simply taking the individuals who used the gun at sea on shore. The army had no experience with the weapon and had not altered its organization to allow training or specialization with the machine gun. Because the machine gun was perceived as artillery and the army was unfamiliar with its use, the Gatling was used in a square formation, which was considered an outdated and less effective formation by the 1860's, more than a decade before this engagement. The commanding officer chose this formation because he desired to engage in a fair fight, to let the Zulus know that the British could defeat them without the "trickery" of modern tactics.[16] 473 Zulus died within a radius of 500 yards of the machine guns in the Battle of Ulundi (1879). The Zulus lost over 1500 warriors while British forces lost only twelve soldiers.[17] Because of the overwhelming success of this battle, the British employed the square formation for all subsequent engagements involving Gatling guns. This means that British not only failed to create new organization when employing the machine gun, but actually reverted to older concepts of operations that had earlier been proven less effective than current tactics.

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[16]John Ellis, The Social History of the Machine Gun (New York: Pantheon Books, 1975) 84.

[17]The Kwazulu-Natal Department of Econmic Development and Tourism, "The Battle of Ulundi" 17 September 2002 http://www.kzn-deat.gov.za/tourism/battlefields/conflict/ulundi.htm (14 May 2002).

The next skirmish to be examined occurred on the other side of the African continent. A nationalistic military party led by Muhammad Ahmad with strong religious and anti-foreign sentiments challenged the puppet government installed in Egypt by the French and British in the early 1880's. On September 12, 1882, British troops attacked the Egyptian rebel stronghold at Tel-el-Kebir, which was defended by 38,000 men and 60 pieces of artillery. The British attacking force at Tel-el-Kebir numbered only 15,000, outnumbered almost three to one. However, the majority of casualties and deaths were Egyptian. Over 2,000 Egyptians were killed and 500 wounded before the Egyptians retreated seven hours after the battle began. The naval machine gun battery, consisting of six Gatling machine guns manned by 30 seamen, was considered the key instrument in the British victory. London newspapers glorified the machine gun and the lopsided victory that it created.[18]

Rumors, myths and folklore began to spread about the power of the machine gun in the more primitive tribes. Because the Maxim machine guns that were used had a small seat for the gunner at the trail piece, there were rumors of men who could assume the common position for relief of nature and eject streams of bullets.[19] Other myths included beliefs that bullets fired over rivers would turn into water or that certain magical potions or talismans would protect warriors from the machine gun's bullets. The tribes certainly did not lack for valor. Warriors were known to launch themselves in wave after wave at machine gun fire.

These same machine guns that were the subject of African tribal myths also betrayed their operators at inopportune times. Early machine guns jammed, because the bullets were not correctly shaped for the barrel.[20] Sometimes only a few rounds could be fired before a malfunction of some sort took place. It was decided that a very skilled troop or officer must be present with each weapon, as they were temperamental and often broke down. Nonetheless, the great successes of the weapon inspired false confidence in many. Dr. Leander Starr Jameson was so impressed with the performance of the Maxim

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[18] Donald Toppel and Paul Wahl, The Gatling Gun (New York: Arco Publishing Company, Inc., 1965) 108.

[19] Ellis, 91.

[20] Ellis, 63.

machine guns during the Matabele war that he decided to bring eight guns with him to combat the Boer commandos in Transvaal (1896). He bragged that with his Maxim guns he would "draw a zone of lead a mile each side of my column and no Boer will be able to live in it".[21] Unfortunately, he did not bring enough water on his expedition to cool the guns, and they jammed almost immediately during the first engagement. He was surrounded by Boer commandos and forced to surrender.

Dr. Jameson would have done well to heed the warnings of Arthur C. Clarke's cautionary tale. The Maxim gun was like fictional army's sphere of annihilation. Dependence on the weapon left both Clarke's fictional army and Dr. Jameson vulnerable when deprived of its use. However, it is the success stories like the Battle of Ulundi that inspire militaries to seek technological innovation.

It can be said that colonial wars in Africa were not exactly a tough test of military effectiveness. While the British forces may have been outnumbered, the playing field was certainly not equal. Futurist Alvin Toffler would claim that most of the tribes the British fought against were first wave societies: focused on agriculture, hunting and producing what one consumed. Britain, a second wave nation, was a leader of the industrial revolution, where weapons and war were mass-produced. The tribal resistance was futile, simply another example of second wave societies overwhelming and eventually replacing first wave societies. In cases of mass disparities between adversaries, technological innovation will produce remarkable triumphs. However, when the machine gun was used between equally advanced nations in WWI, and its main contribution to military effectiveness was an increase in the number of casualties on the battlefield. It was not until the German Army developed storm troop organization and tactics at the end of WWI that the machine gun was effectively used.[22]

A better test of the effectiveness of innovational weapons is the use of chemical agents during WWI. Chemical agents were developed and researched at the turn of the century. Concerned about the ramifications of chemical warfare and how it would redefine the nature of war, weapons whose sole purpose was the dispersion of

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[21] Ellis, 91.

[22] Storm troop tactics and organization will be discussed in more detail in Chapter III.

asphyxiating or deleterious gas were banned in the Hague convention of 1899. This decision was reinforced by the Hague II treaty, which expanded upon the original to also ban the use of poison or poisoned weapons. All future combatants in WWI except the United States, Turkey and Italy were signatories of Hague II.[23]

However, neither Hague I or II had provisions for enforcement of the treaty. France began to develop a liquid explosive, turpinite, that gave off lethal fumes and caused death by asphyxiation. After discovering French research into chemical agents, the German High Command felt justified in being the first power to use purely chemical weapons. Germany is credited with first use of chemical weapons at Ypres, using 180,000 kg of chlorine gas from 5,730 cylinders on the line between Steenstraat on the Yser Canal, at 5 pm on 22 April 1915.[24] The gas cloud blew with the wind, and either killing or causing the French and Algerian troops in the opposing trenches to flee, opening a 8 to 9 km gap in the Allied line. It is interesting to note that the first chemical attacks occurred at Ypres not because the site was suited for such an attack, but because other German commanders refused to use gas in their theaters.[25]

Chemical agents are classified by their effects on victims. Lachrymators are designed to affect the eyes, but may also cause respiratory problems when exposed to a large amount of the chemical, while asphyxiators cause fluid to enter the lungs and slowly deprive the victim of oxygen. Sternutators cause respiratory irritation, sneezing, nausea, and vomiting. Blister agents such as mustard gas initially cause pain in the eyes, throats, and lungs, but later cause blisters on exposed skin.[26] Chemical attacks during the later war years combined several different gases to maximize the damaging effect of the chemicals. Over eighteen different chemical compounds were used as chemical agents, the most common being chlorine, phosgene, diphosgene, chloropicrin, hydrogen cyanide, cyanogen chloride, and mustard gases.[27]

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[23] Brian Blodgett, "Germany's Use of Chemical Warfare in World War I (The Great War)" 1999 http://members.tripod.com/Brian_Blodgett/Chemical.htm#Effective (20 May 2002).

[24] Mitretek Systems, "A Short History of Chemical Warfare During World War I" 11 April 2002 http://www.mitretek.org/home.nsf/EnvironmentEnergy/WWIChemHistory (18 May 2002).

[25] Blodgett.

[26] Blodgett.

[27] Mitretek Systems.

The main methods to deliver chemical agents were by cylinders and artillery. Cylinders were the most common early in the war because they were refillable and Germany lacked sufficient gas-shell production ability. Once Germany created artillery shells that could be filled with chemical agents and maintain a relatively stable flight path, they abandoned unpredictable cylinder-based attacks.

Cylinders released gas clouds that would drift towards the enemy. The placement of cylinders was a time consuming project that took several days of labor. Troops transported the 100-pound cylinders from drop-off points through trenches to the front lines. Soldiers then planted the cylinders in the ground to protect them from enemy artillery fire. The movement and placement of these cylinders was done under the cover of darkness so that the enemy could not detect it. If the enemy detected these preparations, artillery would target these areas with harassing fire. This tactic impeded the placement of the cylinders and sometimes damaged the cylinders themselves, exposing German troops to their own chemical agents.

The speed and direction of the wind was critical to a successful gas cylinder attack. The wind needed to be blowing towards the enemy at a speed sufficient to move it away from the release point, yet slow enough for it to linger over enemy positions. A shift in winds could expose friendly troops to chemicals instead of the intended target. In a series of three gas attacks against Russian troops in vicinity of Bzura and Rawka from 31 May 1915 to 6 July 1915, over 3000 German soldiers became casualties when winds shifted and blew the poisonous chemicals towards the German troops.[28] The lack of favorable winds often delayed chemical operations for days or even weeks. This dependence on uncontrollable factors encouraged the development of artillery-based attacks.

Artillery-based attacks were superior to cylinder based attacks because artillery could be directed at a specific area, a distance from the front lines. Also, artillery shells had been designed to either disperse a quantity of gas over a great distance that would quickly clear up and allow occupation of the area or concentrate gas in a specific area and

[28] Blodgett.

make it uninhabitable for days.[29] By the end of the war, one fourth of all artillery shells were gas. Neither of these strategies were organizationally or strategically innovative. Using cylinders limited the German army's mobility and made them a slave to the winds, and artillery based attacks simply fit into traditional artillery tactics. Even the method of producing the chemicals themselves was not innovative.

German scientists were in the forefront of chemical weapons innovation. Professor Fritz Haber, a Nobel Laureate, was chief of the German chemical warfare service during WWI and is considered the father of modern chemical warfare.[30] However, the chemical warfare service was not an organizational innovation. Over two thousand chemists were employed by the government to create chemical weapons. They worked in isolation, unable to consult with colleagues or collaborate in their efforts, to create large quantities of chemicals. Communications between the chemical warfare service and troops on the front were minimal. Most tactics and operations were created as the troops employed the weapons, not from previous planning or training. Nonetheless, it is estimated that German chemical development was about six months ahead of Allied chemical development.[31] Conversely, Allied innovation in gas masks was superior to German gas mask technology. This is partially due to the limited amount of materials the German military had available for the creation of gas masks.[32] Strangely enough, the chemical warfare service was not responsible for anti-chemical warfare research of any sort.

What is most striking about chemical warfare during WWI was that it wasn't credited with giving either military a decisive advantage over the other. On 22 and 23 July 1916, over 110,000 chemical shells filled with phosgene were fired at the French defense at the Battle of Verdun. Due to a lack of troops, the German military was unable to seize the temporary advantage created. Other attacks were deflected by the use of advanced gas masks. A total of 150,000 tons of chemicals were produced for chemical warfare purposes, and 125,000 tons of that was actually used on the battlefield. The most

[29] Mitretek Systems.

[30] Mitretek Systems.

[31] Blodgett. After the German army first used phosgene, it took the British six months to employ it.

[32] Blodgett.

significant result yielded was an increase in the number of deaths. A. M. Prentiss, author of Chemicals in War: A Treatise on Chemical Warfare, estimated that 1,296,853 casualties were produced by chemical warfare.[33] Other estimates are lower, since they may not take into account soldiers who later succumbed to injuries caused by chemical weapons.[34] Given that there were an estimated ten million casualties during the war, chemical warfare seems to claim a high percentage of victims with little tactical, warfare. Instead of achieving a Jominian decisive victory, chemical warfare seems to have encouraged a costly war of attrition on both sides. The only innovation the weapon offered was to increase the number of battle casualties. Technologically innovative weapons alone seem only to work in limited circumstances, in what would be considered weak tests of innovative weapons. Machine guns will slaughter natives with spears, but two European powers will simply deplete their populations using chemical warfare against each other.

C. TRANSPORTATION TECHNOLOGY

There is more than one way to bring new technology into the battlefield. One method is to have the innovative technology bring you to the battlefield, i.e. new forms of transportation. This will be the technology for the next case study. It will explore the Confederate army's use of the railroad during the Civil War. It is another example of a military that innovated technologically, but did not innovate organizationally.

Friedrich Wilhelm Harkort, a Prussian, was the first to recognize the military potential of the newly established railroads, and presented his ideas of rapidly moving an army across interior lines of communication in the book, *The Railway from Minden to Cologne* in 1833.[35] However, it was in the American Civil War, almost thirty years later that the full scope of rail movement was finally exploited. According to historian Ernest Carter, military operations involving the railroad during the Civil War showed "the great necessity for adequate organizations to cope with the repair of lines damaged by enemy

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[33] A. M. Prentiss, Chemicals in War. A Treatise on Chemical Warfare (McGraw Hill: New York, 1937) 661-666.

[34] Blodgett estimates that was between 300,000 to 900,000 deaths due to chemical weapons.

[35] Ernest Frank Carter, Railways in Wartime (London: Frederick Muller Limited, 1964) 12-13.

action and the systematic disorganization of …railway communication".[36] This lesson was learned from the failure of the Confederacy to fully utilize their railroads.

Railway growth in the United States from the 1820's to 1860's was exponential. At the beginning of the Civil War, the Confederacy controlled 9,000 miles of track. On 18 April 1861, the Confederate army was the first military involved in the conflict to use trains to move troops, only six days into the war. Three trains of Confederate troops were transported to Harper's Ferry. Because of the agricultural nature of the southern states, most railroads were short lines that led from valleys where crops were grown to major ports where goods could be shipped abroad. For example, the Virginia Central line operated slightly more than 200 miles of track with 27 engines and 241 cars in the Upper Shenandoah. The Richmond, Fredericksburg & Potomac operated 75 miles of track with 11 engines and 134 cars. The Manassas Gap operated 100 miles of track with 9 engines and 233 cars.[37] Many of these lines had poor, if any, connectivity to each other. This is because the rails were not of a standardized width, which ranged from 6 feet to 4'10" in varying lines. The tracks themselves were of the older U variety, and not the more durable T variety and were prone to wear quickly under heavy military loads. However, in a few aspects, the railroads in the Confederacy were superior to Northern rails. Unlike Washington D.C., which relied on a single rail track, Richmond had five different tracks leading into and out of the city, allowing for better communication. Also, the Confederacy had the advantage of interior lines of communication.

Railways became central to U.S. military operations, both Union and Confederate. With the introduction of the telegraph, it was possible to communicate quickly with troops hundreds of miles away. Railways were used to move troops, bring supplies to the battlefield and evacuate the dead and wounded. Before the rail, it was necessary for troops to march long distances on foot, often arriving to battles tired and hungry. With the railroad, it was possible for troops to move hundreds of miles in a few days. In previous conflicts, a military's ability to continue fighting depended on its ability to receive supplies, which placed a great deal of pressure on the quartermasters, who were

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[36] Carter, 24.

[37] George Edgar Turner, Victory Rode the Rails (Indianapolis: The Bobbs-Merrill Company, Inc., 1953) 105.

in charge of supplying the troops with food, clothing, ammunition and medical supplies. Therefore, the quartermasters sometimes used the railroads to excess, shipping more supplies than were necessary to the front lines.[38] However, the railroads allowed enough supplies to be transported to the battlefields that meager supply lines was rarely a critical issue.

While military leadership in the Union recognized the importance of the railroads to the war effort and coordinated closely with rail owners and managers, Confederate leadership ignored their deteriorating railways. In 1861, the Confederate Congress refused to pass a law authorizing President Jefferson Davis to assume control of the railroads when military expediency required it.[39] Transportation issues involving the railroads fell to the Quartermaster of the Confederate Army, General Abraham C. Myers. His authority was limited to arranging contracts for transportation of troops and supplies. He was also limited by the existing status of the railroads, as he was not authorized to extend or improve them.[40] Throughout the course of the war, railway operation, management and repair remained a strictly civilian pursuit.

Railroads themselves began to appeal to the Confederate Congress for aid as they were devastated by the war. Military loads were heavier than the loads that the rail systems usually transported, and the weight strained the weak tracks. Also the punishing schedule on the rails to meet the needs of the army meant that rails and cars did not receive necessary maintenance and were pushed until they broke. Attacks on track, engines, cars and bridges were common throughout the war, and since the Confederate government did not authorize the Quartermaster to provide soldiers to guard the rails or repair them after damage, the railroads were bearing the brunt of the cost.[41] Once a few railroad improvement projects received appropriated money from the Confederate government, an onslaught of claims from railroad owners were placed before the

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[38] Turner, 131-132.

[39] Turner, 239.

[40] Turner, 108.

[41] Edwin P. Alexander, Civil War Railroads and Models (New York: Clarkson N. Potter, Inc., 1977) 9-38. It should be said that attacks on railroads were more often perpetrated by Confederate troops, but a few attacks were performed by Union troops as well. Because the Union was much better prepared to respond to attacks on their rails, the attacks on Confederate rails often had greater impact.

Congress. Though many of the claims were frivolous or greedy, they all urged the completion of their particular road as "military necessity".[42]

Even with appropriated money, the Confederacy had little ability to repair and replace tracks and engines lost or damaged as they were lacking in both raw materials and establishments that manufactured engines. The government had appropriated all iron produced in the south and had decided that it was too valuable to expend on railroad repair. In a letter to Secretary Lawton, Captain F.W. Sims complained that: "The government controls everything the railroads need but will not share it with them. So long as that policy continues, railroad service will continue to decline."[43] The supplies he was referring to included rubber for engine tires, iron and steel for stronger tracks and manpower to repair damaged vehicles and tracks. The Confederate government had adopted a policy of "borrowing" tracks and trains from other lines, which was temporary relief at best.

Because the Confederate government failed to coordinate railway transportation for their troops, sometimes the troops took it upon themselves to do so. Especially early in the war, troops were known to commandeer trains to transport themselves to various theaters. The Confederate government's inability to centralize train operations led to military commanders only using rails when it expressly suited their purposes, and failed to encourage them to think of rail transportation as a system that operated as a whole.[44] Another factor that discouraged Confederate troops from using trains was that tracks were not yet standardized in the South, as they were in the North. This meant that most journeys required troops to load and unload themselves and their supplies several times because trains from one railroad could not operate on another railroad.

On 3 December 1862, the Secretary of War nominated William M. Wadley, president of the Vicksburg & Shreveport, to supervise and control transportation with respect to railroads in the Confederate States.[45] He was given a little more authority than General Myers, but he was still incapable of protecting railroads, or forcing them to cooperate. His suggestions for the improvement of the rail system were remarkably

[42] Turner, 234-235.

[43] Turner, 316.

[44] Turner, 109.

[45] Turner, 245.

similar to the system that had already been instituted by the Union army. However, when the Confederate senate refused to approve Wadley's nomination on 01 May 1863, the government abandoned the idea of centrally controlling the railroads for the war efforts. F.W. Sims, who had no more authority than Wadley to affect any change or force cooperation from the railroads, eventually replaced Wadley. The Confederate government did not attempt any other organizational innovation to improve their military usage of the railroads.

The train system deteriorated over the course of the war years, becoming less and less usable as the war progressed. While the Confederate loss of the Civil War is attributable to many factors, the disparity in their abilities to effectively use the same technology highlights the ineffectiveness of transportation technology alone. Without an organization to maintain and defend modes of transportation, the transportation capability deteriorated until it was virtually nonexistent.

D. INFORMATION TECHNOLOGY

The final type of technological innovation to be discussed is information technology. Information technology encompasses both communications technology and information gathering technologies, such as sensors and radars. Cryptography, code breaking, steganography and similar technologies that protect information and communications also fall into this category.

The following two cases examine militaries that improved their information technologies without commensurately improving their organization. Unlike the crushing defeat of the Battle Analyzer in war, neither of these cases provided great victories or devastating losses for the militaries in question. They do, however, demonstrate the futility of adopting new sensing and communications technologies when current tactics and organization only demand earlier, less advanced sensing and communications capabilities. If one can but does not need to communicate more, the information technology tends to be ignored at best and a hindrance at worst. The cases that will be examined are the Battle of Jutland and the United States Army's Force XXI experiments in the late 1990's.

Technology played a large role in the Battle of Jutland. When the British commissioned the H.M.S. *Dreadnought* in 1905, modern battle ships were redefined overnight. H.M.S. *Barram*, a later member of the dreadnought class, became the British flagship at the Battle of Jutland. The H.M.S. *Barram* was the first oil-fired ship with a maximum speed of 25 knots, carrying 15-inch guns, which fired projectiles that weighed 1,920 pounds.[46] The H.M.S. *Barram* also had a radio, which could communicate with other ships or naval establishments at distances of over 60 miles, whereas semaphores and flashing lights, the previous communications technologies, were limited by visibility. Only on a clear day, could ships over ten miles apart successfully communicate with each other. It is this technology that this case study is going to explore. Despite a great deal of technological innovation and a lengthy pause between major naval engagements, the British had not innovated organizationally since the time of Trafalgar, with regards to operational battle fleets. While the results were not as disastrous as the retrograde French tank organization proved to be, the Battle of Jutland did not provide decisive victory for the British.

One of the more notable technological advances of World War I weaponry was the introduction of the radio into the battlefield. Ships were ideal platforms for radios because they had a constant source of power from their engines and a terrain that was free from obstacles. In 1899, Signor Guglielmo Marconi, inventor of the radio, equipped the first British naval vessel with radio.[47] By 1916, most ships in the British fleet were equipped with radio; the task of equipping the entire fleet with radios was completed by 1917.

However, signaling was still promoted as the preferred method of communication, and recently (1908), it had been made an officer specialty, on par with navigation or gunnery. No knowledge of radio was necessary to receive the S (signaling) specialty code. The W/T (wireless telegraphy) was under the control of the torpedomen

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[46] Andrew Gordon, The Rules of the Game: Jutland and the British Naval Command (Annapolis: Naval Institute Press, 1996) 7-9. Previous ships were fueled by coal, a resource that was plentiful in the British Isles. H.M.S. *Barram* created a dependence on foreign oil, which continues to shape politics and national strategy today.

[47] Gordon, 318-320.

(electricians), despite recommendations that the two areas be joined.[48] Because of this, officers were never fully trained in use of the radio and were encouraged to pursue older technology and forms of communication as a new specialty. The Admiralty focused on signaling as a form of communication, and the Signal school was considered the site of lively debate concerning modern naval developments.

The British fleet had not engaged in a major offensive action since the days of Horatio Nelson, over 100 years earlier. Organization in the British fleet had advanced little since Nelson's time, either. "In the Royal Navy during the First World War the continued rigid adherence to eighteenth century line-of-battle strategy is an example of the degree to which the traditional way of doing things dominated naval thinking."[49] According to Sir John Keegan, the British admiralty had fostered an environment where it was next to impossible to learn how to conduct a battle or to innovate in any manner: organizationally, operationally or tactically.[50]

Since organizational innovation was not encouraged, the need for new information technology was not recognized. Senior leadership was not educated in how to use technology, and therefore technology that wasn't transparent (faster ships, better bombs, more armor) wasn't used. The misuse of the radio was apparent in British actions. Admirals preferred to use flag hoists to communicate. This was due in part to the desire to emulate the days of Nelson and also in part to the "fetish of secrecy and an undue obsession with the dangers of detection".[51]

At 15:45 on May 1916, the Battle of Jutland began when Vice Admiral Sir David Beatty, Commander of the First Battlecruiser squadron, of the Royal Navy spotted Admiral Franz von Hipper's fleet of forty ships sweeping the Danish coast. After spotting the German fleet, Admiral Beatty raised his flag hoist, signaling to the other ships to follow his lead, but did not duplicate his message via radio. Only five other

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[48] Gordon 363, 424.

[49] John K. Gusewelle, "Science and the Admiralty during World War I: The Case of the Board of Invention and Research", Naval Warfare in the Twentieth Century, ed. Gerald Jordan (London: Croom Helm, 1977) 115.

[50] John Keegan, The Price of Admiralty (New York: Penguin Books, 1988) 121-122.

[51] John Slessor, "Admiralty Command Policy in Two World Wars: Reflections based on Arthur Marder's Story of Jutland," Naval Warfare in the Twentieth Century (118-127) 121.

battle cruisers followed his lead towards the German Fleet, and Beatty's squadron was consequently outmatched and destroyed by the opposing fleet. Alerted to the German presence, Admiral Sir John Jellicoe, First Lord of the Admiralty, directed his fleet towards the Germans. However, he received little information on the whereabouts of the fleet and wasted time searching for the melee. Historian Andrew Gordon feels that Commodore William Goodenough, Commander of the 2nd Light cruiser Squadron, failed in not sending timely W/T transmissions. Light cruisers were tasked with reconnaissance and the relying of information to the main battle fleet, as they were not strong enough to engage a battleship. Though he sent three position reports via W/T between 1615 and 1700, his lack of transmissions after damage to his radio sets prompted Admiral Jellicoe to break radio silence twice to inquire about Goodenough's location. Instead of sending W/T transmissions via one of his subordinate ships with a functioning radio, Goodenough chose to communicate via semaphore.[52] Meanwhile, Admiral Reinhard von Scheer's High Seas Fleet joined the fray and continued to pummel Beatty's squadron until Admiral Jellicoe finally brought the Grand Fleet to Beatty's defense. When the German navy noticed the Grand Fleet closing in, Scheer ordered a withdrawal towards the north. Admiral Jellicoe gave chase and intercepted the Germans twice for brief engagements before the German High Seas Fleet successfully escaped.[53]

Radio communications hindered the British efforts several other times during the course of the battle. Ship captains spent five to ten minutes sending radio messages with casualty reports while their ships were still under enemy fire. Other times, messages were coded, wasting precious time in coding and decoding, when immediate action was required. H.M.S. *Lion* apparently lost the radio challenge and reply for the evening of the attack and asked for it in the clear, by flashing lamp, which was a great compromise of security.[54] While the shore-based commands relied upon radio transmissions, the British navy ignored the radio's capabilities once they left port.

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[52] Gordon, 419-424.

[53] "Jutland," 13 February 2002 http://www.spartacus.schoolnet.co.uk/FWWjutland.htm (15 May 2002).

[54] Slessor, 121.

After the Battle of Jutland, both the British and Germans claimed victory. The Germans lost 11 ships and 2195 sailors, and the British lost 14 and 5914, respectively.[55] Historians generally award the win to the British navy because they retained the capacity to mount another major naval campaign, whereas Germany's Risk Fleet went out of its way to eliminate the chance of facing British fire. Unlike Clarke's fictional military, the British Navy did not collapse when their new information system failed. Their old information system provided sufficient ability to communicate. However, it can be argued that if the British had made better use of the radio, Admiral Beatty's four fast battleships would have been present at the first engagement with the Germans and could have prevented the slaughter of the British battlecruisers. Had the British made better use of the radio, they might have inflicted more damage on the fleeing Risk Fleet by signaling their positions and giving ADM Jellicoe the information he needed to locate the German fleet. They might also have been able to save the lives of fellow sailors in floundering ships.[56]

Another example of a military hindered by its new communications technology is the United States Army's recent Force XXI experiments. Force XXI is the United States Army's vision of future forces, which have been equipped with the latest sensing and communications technology. The principal goal of Force XXI is to improve sensing technology in the hopes that better situational awareness will improve unit effectiveness. Force XXI also seeks to allow the reduction of intermediate staging requirements and reduce the time required to bring troops into combat, allow nonlinear operations and reduce the footprint of American forces by dispersing them throughout the battlefield. Other goals include paring down logistics and deploying fewer support personnel by "beaming" them into the battlefield.[57]

The central technology in this effort is the Force XXI Battle Command Brigade and Below (FCBB2) command and control system. Large computer screens, known as

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55 John Campbell, Jutland: An Analysis of the Fighting (Annapolis: Naval Institute Press, 1986) 337-341.

56 John Keegan shares a particularly haunting vingnet in The Price of Admiralty where the ships of the Grand Fleet cheered as they passed the wreck of H.M.S. *Invincible*, convinced they were passing the wreck of a German vessel.

57Jennifer Morrison Taw and Michelle Zanini, Multinational Force Compatibility (RAND: Santa Cruz, California, 2000) 15-16.

appliqué, are found at all the command posts and various platforms. On the appliqué, one can see the status and location of both friendly and enemy forces, improving situational awareness.[58] This information is fed into the main system by sensors that are attached to various battlefield platforms, including tanks, artillery and the M-16s of the infantry. What have not been updated in the Force XXI army are the organization of the units in battle and the concepts of operations. Units participating in the battle experiments are organized and trained in traditional battlefield tactics. RAND analysts claim that Force XXI is mired in the air-land battle doctrine of the Cold War.[59]

In March of 1997, war-fighting experiments involving Force XXI began at the National Training Center in Fort Irwin, California. While the local media and Army publicists emphasized the high-tech wizardry of the new weapons systems, not everyone was pleased with the results. The Office of Operational Test and Evaluation in particular was alarmed by the results of the war-fighting experiments. Their primary concern was that participants had difficulty distinguishing "good guys" from "bad guys" on the battlefield, resulting in as many friendly-fire accidents as the last three non-digitized training experiments combined.[60] Other concerns included inadequate unit training, immature technologies, and the need for on-the-spot work-arounds for malfunctioning systems.

In his "lessons learned" paper, COL Rick Lynch, the commanding officer of the 1st Brigade Combat Team (1BCT), 4th Infantry Division at Fort Hood, Texas pointed out several other weaknesses of Force XXI. The 1BCT was designated to be the first digital brigade and performed the majority of the Force XXI experiments at NTC (National Training Center). His most telling comment is that "technology isn't the panacea for poor training".[61] Because of the time spent training soldiers to use new systems, the time spent training them in classic battlefield maneuver was reduced, hurting their

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58 United States Army, Weapons Systems 2001 (Washington: GPO, 2001).

59Taw and Zanini, 15-16.

60Gregory Slabodkin, "GAO: Pentagon must play larger role in Force XXI," GCN 27 July 1997: 2. There were 32 incidents of fratricide in the Force XXI experiments and 28 incidents of fratricide in the last three experiments combined.

61 Rick Lynch, "Commanding a Digital Brigade: Tactics, Techniques and Procedures," Center for Army Lessons Learned June 2001: 1.

performance. Even though Force XXI was able to see the enemy before the engagement, once the units were within firing range, the differences between the Force XXI Brigade and the NTC force in battle-space awareness were negligible and the poor training of the 1BCT showed.[62]

In order to combat the system failures, 1BCT brought both the Force XXI technology and the older legacy systems into the battlefield, to ensure that at least one command and control system was operational. This mandated increasing the size of the force brought to the field, as both systems needed to be maintained, and negated the goal of bringing a smaller, nimbler force into the field.[63] Also, the weight of new technology in terms of the sheer amount of weight a soldier carried with him into the battlefield often outweighed the benefit it brought in terms of situational awareness.[64]

One thing that was notably missing from the Force XXI plan was new organization, tactics and strategy. Though some acknowledged that the improved sensing capabilities could allow for more independent action, no such action was taken during the battle experiments. The results were that Force XXI was not the much more successful than conventional units fighting the same enemy at the National Training Center.[65]

In examining these two cases, one can conclude that the organization, tactics and strategies employed in the past two cases nullified the potential use of new sensing and communication technologies. A military advances as far as its organization will allow. The decision-making capabilities of the Royal Navy at the Battle of Jutland were the same as during the days of semaphore and flashing lights. The admirals of the day were not accustomed to the new wireless technology and chose not to employ it at critical moments. The outcome of the Battle of Jutland could have been more favorable to the British navy had they employed their radios well, but as the radios were employed, the outcome would have been remarkably similar if British had not had the technology at all. Force XXI suffered from immature technology that hindered what benefits they might

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62 Samuel Amber, CAPT USA, personal interview, 13 Feb 2002.

63 Lynch, 16-21.

64 Amber, interview.

65 Interview. Most of the battles with the army unit that trains full-time at the National Training Center resulted in a draw. The typical unit arriving at the NTC achieves a few victories, more losses, and mostly draws.

have received from a smaller, nimbler force by supporting two command and control structures. They also did not take advantage of their ability for independent action, and were forced into the classic battlefield tactics that they were poorly prepared to use. The captains at the Battle of Jutland did not need the radio and the battlefield commanders at the National Training Center did not need Force XXI technology. They were perfectly capable of making decisions with their old technology.

If new technology, especially information technology, is not incorporated into strategy, doctrine and organization, then it is more of a hindrance than a help. This is especially true in these last two cases because it is more natural to consider new organization with new forms of firepower or modes of transportation. Even the French Army considered and then rejected new armored divisions, while new organization for Force XXI was never given serious thought.

F. CONCLUSION

What are the themes that these cases illustrate? They suggest several things, the most important of which is that technological innovation alone is often not as successful as its owner would like it to be. Throwing technology at the battlefield is not a panacea for an ineffective organization or the difficulties of war. Sometimes one will achieve stunning victories, like the machine gun did in the colonial wars in Africa. However, for every Battle of Tel-el-Kebir, there is a corresponding Battle of France that failed. Even in cases where overwhelming technological superiority cowed the enemy, technology is not always the godsend it appears to be. The Vietnam War is an example where a technologically advanced military was beaten back by forces using begged, borrowed and stolen technology, which did not compare to the technology that that was available to the United States. This superiority can lead to dependence on a complicated and frail piece of equipment that has not yet proven its effectiveness in battle. What happens if the equipment is taken away or no longer functional? Recent trends also suggest that it will become more and more difficult to achieve the technological superiority that overwhelmed the African tribesmen, and that arms racing will prove even more costly. The U.S.S.R. spent itself into bankruptcy trying to compete with American technology. No military, no matter how advanced, is immune from this threat.

The advantage now lies with the military that learns how to best manipulate technologies to their advantage and organizes themselves to do so. This is shown in the case of railroad use during the Civil War. The Confederate government refused to take responsibility for the rail system, allowing civilian enterprise to bear the brunt of the burden of maintaining and repairing roads during wartime. The condition of Confederate railways consequently declined, whereas the Union railways remained functional throughout the course of the war. While technology is available to anyone who can open his pocketbook wide enough, organizational innovation is not. The ability to reorganize and rethink traditional methods of waging offensive and defensive campaigns is going to be the valuable commodity in today's information-driven, technologically rich battlefield. Conflict in the future will prove the axiom that technology is only as good as the man who uses it.

On the flip side, militaries also have a tendency to ignore the capabilities of new technologies that are available to them, because of their unfamiliarity with them, specifically communications technology. A brief chat with the Admiral's secretary at the Naval Postgraduate School reveals that the Admiral spends a portion of each day swearing at his computer, trying to reformat documents. This is similar to the case of the Battle of Jutland, where captains of ships either ignored radio communications or spent an inordinate amount of time trying to send messages when their attention would have been better directed towards the rapidly changing tactical situation. However, new abilities to sense and communicate may allow for the greatest possible organizational innovation.

Overall, bringing new technology into a military's arsenal seems to have disappointing results. Arthur C. Clarke's story of a military defeated by its inability to handle its own advanced technology should serve as a warning to militaries. Technology in itself is neutral. It is how it is used that makes the difference.

III. ORGANIZATIONAL INNOVATION

A. INTRODUCTION

Militaries can choose to modernize themselves purely by means of organizational innovation. Stephen Peter Rosen, professor of National Security and Military Affairs at Harvard, defines a major military innovation as "a change that forces one of the primary combat arms of a service to change its concepts of operations and its relation to other combat arms, and to abandon or downgrade traditional missions. Such innovations involve a new way of war, with new ideas of how the components of the organization relate to each other and to the enemy, and new operational procedures conforming to those ideas. They involve changes in critical tasks, the tasks around which warplans revolve."[66] This definition leaves open the possibility of introducing new technology as a type of innovation. Organizational innovation as it is defined for the purpose of this thesis will consider the introduction of new technology into organizational innovation as a third type of innovation separate from purely organizational innovation.

Therefore, in this thesis, organizational innovation is defined as an innovation where one of the primary combat arms of a service adopts new ideas of how the components of the organization relate to each other and to the enemy, abandoning or downgrading traditional missions. Organizational innovation involves recognizing and deciding on new critical tasks. Some organizational innovations that will be explored in this thesis include Admiral Nelson's victory at the Battle of Trafalgar, the Boer Commandos in Transvaal and the Free Orange State during the Boer War, the Royal Navy's decision to adopt convoying during WWI and Ludendorff's storm-troop squads during WWI. What all of these organizational innovations have in common is that new war-fighting capabilities were introduced simply by reorganizing the manner in which the forces fought and technology was used. Organizational innovation may not involve any new technology. It simply makes the most effective use of what is available.

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66 S.P. Rosen, "New Ways of War: Understanding Military Innovation," International Security Summer 1988: 134.

Organizational innovation is sometimes considered the "war of the weak" because it is employed by militaries that have no other options in modernizing their forces. Jarat Chopra, professor at Brown University's Watson Institute for International Studies, defines "war of the weak" as revolutionary warfare during the 20th century, where war become politics, as opposed to remaining an extension of politics. This reorganization tied the military much more closely to governing authorities and was advocated by Lenin, Mao Ze-Dong and Ernesto "Che" Guevara.[67] Even the advocates of this type of warfare tried to distance themselves from the stigma of being considered weak. Mao Ze-Dong, whose writings heavily influenced the Viet Cong in their tactics and strategy during the Vietnam war, wrote that his army should "oppose guerrilla-ism in the Red Army, while recognizing the guerrilla character of it operations".[68] Even Mao hoped that the Chinese Red Army would eventually be able to face its opposition in a more conventional battle. He hoped that a conventional battle would bring a decisive victory and cut short protracted war. Alvin and Heidi Toffler have noted that organizational innovation has become a much less popular option for military innovation since the industrial revolution.[69] As such, militaries that innovated in this manner are considered to have been "forced" into a new organization by their limited financial resources or limited personnel.

This chapter will explore several different militaries that have innovated organizationally and not technologically. It will explore militaries that were forced into innovating organizationally in order to survive. The Boer War will be explored as an example of a military forced to innovate or cease existing. Cases of militaries that chose to innovate organizationally, even though they had the means to innovate technologically will be explored as well. The use of convoying by the British Navy during WWI and Admiral Nelson's victory at Trafalgar will be explored to illustrate this phenomenon.

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67 Jarat Chopra, "Back to the Drawing Board," The Bulletin of Atomic Scientists March/ April 1995:.

68 Mao Zedong, "Strategy in China's Revolutionary War," Selected Writings of Mao Tse-tung (Beijing: Foreign Languages Press, 1967) 977.

69 Alvin Toffler, Future Shock (New York: Random House, Inc., 1970) 20-25. John Czarnecki, personal interview, 21 February 2002. Toffler argues that technology feeds on itself, and that its use creates demands for more technology, which has accelerated dramatically since the industrial revolution. By inference, one can assume that technological innovation has become preferred over organizational innovation. Toffler continues by noting that rapid technological innovation will soon make rapid organizational innovation necessary as well.

Finally, this chapter will look at an example of a military that innovated organizationally but was unsuccessful (met with defeat) in their attempts. That case is the German defeat in the spring of 1918 after the failure of General Ludendorff's offensives. In deference to the Toffler's theory, these cases will be discussed in chronological order.

B. THE BATTLE OF TRAFALGAR

The first case chronologically is the Battle of Trafalgar where Admiral Horatio Nelson dealt a devastating blow to Franco-Spanish naval power. The innovative organization of the British fleet used at the Battle of Trafalgar influenced navies of the world for many years to come.

Napoleon, Emperor of France, had always been an admirer of Alexander the Great, and like him aspired to conquer the whole of Europe. Great Britain remained the most persistent obstacle to his aspirations. He decided that the best way to overpower the British was to lure their navy to the opposite corner of the globe before attacking the remnants of the British fleet and invading the British mainland. By sending his fleet to secure French interests in the Caribbean and conquer Dutch vessels stationed there, Napoleon hoped to tempt the Royal Navy into following the French navy across the Atlantic and protect their own territories in the Caribbean. Thus, the prelude to the Battle of Trafalgar included a chase across the Atlantic and back, as Nelson pursued Admiral Pierre-Charles Villeneuve, Commander at Toulon, and his fleet. When the French fleet returned to its homeport, a blockade was organized to report on its movements.

The naval technology of 1804 had not changed significantly in centuries. Since the commissioning of H.M.S. *Sovereign of the Seas* in 1637, the first rate ships of the line had been 100-gun three-deckers, and the size, speed and shape of naval war ships remained relatively constant until the time of Trafalgar.[70] Though improvements in metallurgy and gunnery allowed for larger and more powerful cannons, this was an incremental and not dramatic improvement in war vessels. A reliable chronometer was invented in the 1760's and was used for navigational purposes until the invention of radar. The telescope was invented in the 1600's and was a staple aboard ships. The most recent bit of technology aboard ships was a new vocabulary signal book created by

[70] Brian Lavery, Nelson's Navy (Annapolis: Naval Institute Press, 1989) 43.

Admiral Home Popham. It allowed commanders to spell out their orders simply and communicate more effectively by creating a pseudo-alphabet with differently colored flags. It also had an index of 3000 common orders that could be issued with a single flag hoist.[71]

Operational naval fleet organization also had not changed in the last hundred years. Fleets about to engage in battle attempted to sail in formation, a single long line of ships. They then lined up facing each other and fired upon their opponents until one party was sunk, boarded, surrendered or escaped the conflict. Being upwind of the of opponent could be a tactical advantage because of better visibility, but it also committed a navy to an offensive battle, as it was much easier to break away and run if one was downwind of the opponent. Because of this, the emphasis was on ships that carried the most guns, as that was the only way to gain an advantage in such a battle.

Nelson decided that for the decisive victory that the British Navy was seeking, new organization had to be used. The limiting factor in British tactics was the Admiralty's insistence on the fleet organizing itself into a single line. British admirals were expected to follow fighting instructions written in 1690 and those who didn't sometimes found themselves court martialed.[72] Ships were prohibited from breaking away from the line to pursue independent action in Article 20 of the permanent instructions, which stated that "None of the ships of the fleet shall pursue any small number of enemy's ships till the main body be disabled or run".[73] This left a very limited role in battle for subordinate admirals who commanded divisions of the fleet. Subordinate admirals were directed to be attentive to the flagship, ensure the ships in the vicinity received the communications and ensure that nearby ships remained in formation.[74] Trusting the experience of his subordinate, Admiral Cuthbert Collingwood, Nelson decided to divide his fleet into two squadrons in order to pursue independent action in battle. This is Nelson's organizational innovation: dividing his fleet in two divisions and allowing for autonomous action. This innovation would allow him to

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71 John Keegan, The Price of Admiralty (New York: Penguin Books, 1988) 51-52.

72 Lavery, 255. Admiral Mathews was court martialed in 1741 for failing to forma line of battle when engaged off the coast of Toulon, France. Keegan, 45. Admiral John Byng was executed for violating the standing orders and consequently losing the Battle of Minorca.

73 Lavery, 255.

74 Lavery, 259.

"cross the T", where a fleet could intercept an opposing fleet by crossing perpendicularly in the middle of the opponent's line. Nelson desired to "cross the T" in two places along the French line, dividing the fleet into thirds, so as to allow the dispersion of attacking vessels. Crossing the T would allow the attacking vessels to "rake" the sides of their opponents' ships from bow to stern while being protected from fire themselves, as the guns on warships were fixed and only allowed firing in two directions. Once a ship broke through the line, the opponent could be attacked on both sides and surrounded. Unlike the better trained British fleet, most French and Spanish vessels were only prepared to fire from one side of the vessel at a time, so the opponent's confusion as to which side to defend would give Nelson an additional advantage.[75] This action would also isolate the enemy van (front of the line), effectively taking those ships out of action because they would have to head into the wind to rejoin the fight. Using these tactics, it would be important for the British to take the offensive windward (upwind) side of their opponents, allowing them to maneuver quickly and take advantage of their superior seamanship.

It was Napoleon's threat to replace Admiral Villeneuve with his rival, Admiral Francois Rossily, which finally drove Villeneuve to action. On the morning of 19 October 1805, the Combined Fleet of French and Spanish warships left Toulon with thirty-three ships.[76] A British frigate spotted them and Nelson was informed by mid-morning. He set off in the direction that the French were heading. On the morning of 21 October 1805, the British found themselves nine miles away from the combined fleet, off the shoals of Cape Trafalgar. By mid-morning, Nelson had raised the signal "prepare for battle".

The night before the engagement, Nelson had hosted the commanding officers of all his ships on board the command ship to fully explain his ideas. Good communications were key, as the reorganization of his fleet would make it difficult to signal once the battle began. Because of the experience of his senior leaders and the loyalty of his wardrooms, Nelson's instructions were carried out well. The British took twenty ships of

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[75] Keegan, 31- 41.

[76] Keegan, 55. The Spanish government had formed an alliance with the French against the British. The combined fleet consisted of both French and Spanish ships. To be fair to Admiral Villeneuve, the majority of the sailors in the fleet were remarkably inexperienced and Villeneuve had to simplify most of his orders to ones they were capable of executing. This contributed greatly to his devastating defeat.

the Combined Fleet. Unfortunately, they only came home with four prize vessels, due to bad weather that hit immediately after the battle and the weakened condition of all ships involved. It is estimated that the Combined Fleet lost 8,000 sailors while the Royal Navy suffered 437 dead and 1242 wounded.[77]

Nelson's victory at the Battle of Trafalgar was stunning, with a grave impact on the future of French-British relations. From that point on, Napoleon had to abandon thoughts of invading Great Britain and focused his aggression on other continental powers. Though Napoleonic France remained a continental power for several years, Nelson delivered a definite blow to the French navy. What is most remarkable about this case is that even though there was no pressure on Nelson to innovate other than his own desire for a decisive victory, he innovated admirably. It could be mentioned that the only form of innovation available to Nelson was organizational, as he did not personally have the capital to investigate technological innovation. This organizational innovation was also unusual because it was within a military that had been successful in recent history. After all, the British navy had defeated the French in their last four engagements.[78] Most militaries that innovate organizationally do so because recent losses demonstrated a need to the leadership for new organization. It is a tribute to the military genius of Nelson that he recognized an opportunity for organizational innovation.

C. THE BOER WAR

The next case study is of a military that innovated organizationally because recent losses demonstrated a need for new organization. The natives of Transvaal and the Free Orange State had all but lost a conventional war with the British, so an unfamiliar organization and a new approach to war were was chosen as the only viable alternatives. This is the case study of the Boer Commandos during the Boer War (1899- 1901).

The Boer War began over the British desire to control the gold mines near Johannesburg in what was then Transvaal and add those territories to their colonial possessions. Two nations, Transvaal and the Free Orange State combined forces to preserve the autonomy of their nations. The Boers first sought diplomatically to limit the power of the "uitlanders", or foreign whites, that flocked to their country. The military

[77] David Lyon, The Age of Nelson (Annapolis: Naval Institute Press, 1996) 136-139.

[78] Lyon, 113.

confrontation began in October of 1899. The Boers mounted a traditional defense against the British, confident that their superior rifle, the German-made Mauser, horsemanship and marksmanship would overpower the British. The Boers quickly invaded and sieged Mafcking, Kimberly and Ladysmith in an attempt to take the offensive. Unfortunately, the massive number of British troops in the area negated these advantages quickly. The strategy chosen by the Boers forced them into a conventional war with the British, where they could not use their mobility to their advantage.[79]

The Boer military organization was unsuited for conventional warfare, which required a defined command structure. The main unit of Boer combat organization was known as the Commando, which consisted of every man in an electoral district, of which there were over 40. Because of the varying sizes of the electoral districts, Commandos ranged in size from 300 to 3,000. Leaders were not professional military officers, but were rather elected by the members of each Commando. Larger districts also elected field cornets. Because of the ad-hoc nature of the force, traditional military discipline was unheard of, and troops were free to enter and leave the military as they saw fit. Similarly, there were no designated uniforms and soldiers were required to bring their own horses, weapons, ammunition, food and supplies.[80]

For a time, the British strategy of advancing directly along the railroad lines allowed the Boers to maintain an advantage despite their ill-advised tactics and organization. The Boers took positions on kopjes (small hills) and sniped the advancing British troops. However, with the arrival of Field Marshal Lord Frederick Roberts in January 1900, the tide was turned. By using flanking movements to disguise their actions, the British captured the capital of Orange Free State on 13 March 1900. Field Marshall Roberts then captured Johannesburg on 30 May 1900 and Pretoria on 5 June 1900.[81] With the capture of the capitals complete, the British expected the Boers to agree to a complete surrender. The majority of the Boer military leadership had been captured, killed in action or had left the county in disgrace. The British had not expected a younger generation of military leadership would seize the opportunity to take charge and innovate

[79] Bevin Alexander, The Future of Warfare (New York: W.W. Norton and Company, 1995) 88-91.

[80] Alexander, 90-91.

[81] Eversley Belfield, The Boer War (London: Leo Cooper, Ltd., 1975) 93 –100.

organizationally. [82]

The most influential of the new emerging leaders was Christiaan De Wet. He recognized that the military strength of the Commando force lay in its mobility. They could use their superior mobility to their advantage and attack lightly defended units with small bands of men, ranging in size from 50-300 men. Each of these bands would be based in the district that they lived, allowing the soldiers to disperse after the action and return to their civilian lives. With very few exceptions, soldiers did not travel outside of their home district or attempt any action with more than 300 men. Because of this, most operations were independently undertaken. Another change in the Commando organization was leaders were selected by experience as opposed to popular elections. Emerging leaders such as James Barry Hertzog, Koos de la Rey and Jan Smuts were selected because of tactical knowledge and battlefield experience, creating a more professional leadership.[83]

The Boer strength varied during this phase of the war; as members could join and leave the army at will, but it never numbered more than 15,000.[84] The guerilla tactics developed by De Wet focused on attacking the railroads that were used to supply the British troops. The Boers destroyed the tracks, looted the supply trains and attacked the sentries designated to guard the tracks. Between October 1900 and September 1901, the British rail lines were cut 195 times.[85] Attacking the rail lines was beneficial for the Boer army for two reasons. First, it separated the British from their supplies, as the lack of indigenous support meant that most of the British supplies had to travel great distances. Even though the British military adopted flanking movements, they still depended on a long supply train that began at the railheads. Second, it provided the Boer army with the majority of their supplies. Also, this sort of ambush was the attack that the Boer commandos excelled in. As the war continued, the Boer commandoes abandoned their more accurate Mauser rifles and started using British Lee-Metford rifles because parts

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[82] Alexander, 102.

[83] Belfield, 104.

[84] This number is disputed. Bevin Alexander claims in The Future of Warfare that the Boer Commandos never numbered more than 15,000. In The Great Anglo-Boer War, Byron Farwell claims the number was as high as 25,000.

[85] Byron Farwell, The Great Anglo-Boer War (New York: Harper and Row, Publishers, 1976) 326.

and ammunition were readily available for the latter weapon.[86] Since they had no ability to actually feed, cloth and house prisoners and because the Commandos were short on clothing, most captured soldiers were simply stripped of their possessions, including their clothing, and sent on their way.[87]

The British spent a disproportionate amount of time and effort attempting to hunt down Commandos. When a Boer party of 362 under the command of Jan Smuts crossed into South Africa to unite the Afrikaner population against the British, over 15,000 troops were designated to root out the infiltrators.[88] The most remarkable Boer victory was one of the rare actions that engaged more than 300 men. Lord Paul Sanford Metheun was leading a group of 1,300 troops and four guns that was attacked by 1,100 Boer commandos. By first attacking the rear guard and then the right flank, Boer Commander Koos De La Rey wore down the British forces and achieved a remarkable victory. The British forces lost 68 dead, 121 wounded and 600 captured, including General Meuthen.[89] It was this victory that worried the British leadership and led to political concessions on their part.

After this 3 March 1901 victory, Boer victories were few and far between. The systematic construction of Blockhouses across the land by the British made it difficult for the commandos to travel freely. Many Boers had been captured, injured, interned, conscripted into the British forces or decided to work in the mines to support their families. On 15 May 1901, delegates of Transvaal and the Orange Free State met in Vereeniging, and on 31 May 1901 a truce was agreed upon. Under the conditions of the peace, the Boers received responsible government, no war tax, no vote for the black natives, Afrikaans was to remain an official language and the Boers were allowed to keep their personal weapons.[90] While this was not an out-and-out victory, as the Boers still had to swear allegiance to the British crown, the terms of the truce were an improvement over the unconditional surrender the British had demanded before the Boers innovated

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[86] Falwell, 381.

[87] Falwell, 380.

[88] Falwell, 336.

[89] Falwell, 391.

[90] Alexander, 116.

organizationally and demonstrated their military effectiveness. The Boers had shifted their focus from a conventional war, in which they were greatly outnumbered, as they never had more than 70,000 soldiers total and 25,000 troops in the field at any time against a force of 500,000 British troops (including colonials) to an unconventional, distributed war by means of organizational innovation.[91] By dividing into smaller units permanently located in specific geographical areas, the Boers were able to sustain themselves and forced the British to negotiate.

When one looks at the case of the Boer innovation, one wants to dismiss it by pointing out that the Boers were forced to innovate or cease existing. They had no international support of any kind because nations were afraid of offending Great Britain, no national treasury to equip or train their army and a limited number of men and supplies available.

D. ADOPTING THE CONVOY

The next case to be examined is the British decision to use convoying techniques to protect shipping that was attacked by German U-boats during WWI. The British navy had the resources and national infrastructure to choose between multiple solutions to the difficulties they faced. Organizational innovation was chosen over technological innovation.

The convoy is widely heralded as an operational solution to the submarine threat during both World Wars.[92] It is curious to note that Kaiser Wilhelm II was as reluctant to engage in indiscriminant *guerre de course* (commerce raiding), as the British Admiralty was to adopt convoying as a defensive measure against the German U-boats. After the commander of the U-9, Kapitan-leutnant Otto Weddigen, sank three British cruisers, H.M.S. *Aboukir*, H.M.S. *Hogue* and H.M.S. *Cressy* in one day on 22 September 1914, the German high command began to investigate the possibility of using the submarine to weaken the British resolve by commerce raiding.

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[91] Belfield, 148. The term colonial refers to soldiers who were citizens of Transvaal, Orange Free State or other neighboring nations that fought against the Boer Commandos. The British also used African natives as guards for blockhouses.

[92] Roland Bowling, CAPT USN (Ret), "The Negative Influence of Mahan on the Protection of Shipping in Wartime," Diss. University of Maine, 1980, 54-56, 472-473.

After the Battles of Verdun (21 February 1916 – 18 December 1916) and the Somme (1 July 1916 – 18 November 1916) , the German High Command decided that no decisive victory could be achieved on land. As their resources were quickly being depleted, they saw themselves with three remaining options. The first was to sue for peace while terms of the agreement would be favorable to them, the second was to re-open unrestricted submarine warfare and attempt to starve the British into submission and the last was surrender. After the British rejected German overtures for peace, the second declaration of unrestricted submarine warfare was made on 29 January 1917 and took effect 1 February 1917. The German submarine force proceeded to sink 4,837 merchant ships and 12,500,000 gross tons of shipping until the end of the war.[93]

Great Britain had been feeling the stain of attacks on its shipping throughout the entire war. However, there was great internal conflict about the proper solution to the submarine threat. The Admiralty had adopted a primarily Mahanian view of naval warfare, and saw commerce raiding as a secondary effort. The main thrust of a nation's navy should be the battleship and the blue-water navy was the mantra of most of the Admiralty.[94] Perhaps because the British had the resources to consider different forms of technology as a solution to the submarine threat was the reason they were so slow to adopt convoying as a solution.

Several solutions were tried to ameliorate the submarine threat before the convoy system was adopted. Starting in the spring of 1915, the Allies established a system of patrols and drift nets around the Mediterranean. The nets were large steel contraptions meant to entangle and trap enemy submarines or force them to the surface where they could be spotted. The shortage of steel in the Allied nations made this a particularly impractical solution. Several destroyers were embarked on "sub-hunting" missions, a pet project of Admiral Jellicoe. Many areas were mined to deter submarines. In addition to these solutions, the Admiralty recalled to duty Admiral Sir John Fisher, who was tasked with reviewing suggestions and ASW inventions offered to the Admiralty by the public. 40,000 inventions poured into his office, but not one was deemed practical enough to be

[93] Bowling, 98.

[94] Bowling, 51-52.

worthy of a trial. Thus, the Admiralty decided that new technology was not the solution to the submarine threat for the foreseeable future.[95]

The Admiralty resisted convoying for several different reasons. It felt that convoying was old-fashioned and that modern technology had rendered this tactic obsolete. The Admiralty was also concerned that convoying would require a force of several destroyers to one merchant vessel in order to be successful. This stemmed from mistrust in the merchant marine's ability to keep a tight formation and maneuver *en masse* effectively. Because of this distrust, the Admiralty was convinced that it would require a massive fleet of destroyers to escort convoys, which they did not have at their disposal. They were not inclined to detach any of the 100 destroyers attached to the Great Fleet resting at Scapa Flow. Perhaps this is because as Mahanian disciples, they did not fully appreciate the importance of commerce and shipping to the war effort. There was also a concern with clogging local ports as ships waited for escorts. The delay in shipping time would make convoying an undesirable option to businesses, it was claimed. It was commonly thought that convoying would provide a richer target for submarines. In fact, when the U-boat threat first emerged, the Admiralty endorsed the anti-convoy: sending merchant vessels alone in a multitude of different directions.[96]

Not everyone in Great Britain felt the same way about convoying. Lloyd George was an avid proponent of convoying, and once elected Prime Minister, used his position to advocate the use of convoys to the point of irreparably damaging his relationship with the Admiralty.[97] Foreign merchants lost confidence in Britain's ability to protect their vessels and demanded convoys a few months after the institution of unrestricted submarine warfare. Therefore, trade to Scandinavia was convoyed several months before the Admiralty instituted universal convoying for all merchant vessels.

Admiral William S. Sims, United States Navy, was appointed the U.S. liaison to Great Britain after the United States entered the war and advocated convoying after his arrival on 10 April 1917. American support, both monetary and military, would be vital to the successful convoying effort. But what actually convinced the Admiralty to

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[95] Bowling, 155.

[96] Bowling, 111.

[97] John Winton, Jellicoe (London: Michael Joseph Ltd., 1981) 240-245.

experiment with convoying was the desperation of their situation. Twenty five percent of all commercial vessels venturing into international waters did not see their destination ports. The feeling amongst many leaders was that Great Britain could not sustain the war effort much longer with such great shipping losses. In the month of April 1917, alone, 750,000 tons of shipping was lost.[98]

One reason Lloyd George found himself so unpopular in the Admiralty was his research into "the organization of the Admiralty and more particularly of the War Staff, in connection with Anti-Submarine warfare" on his 30 April 1917 visit.[99] The war cabinet approved his proposal for reorganization of the Admiralty and War Staff on 02 May 1917. Admiral Jellicoe became the Chief of Naval Staff, which gave him executive power, which he didn't have while serving as the First Sea Lord. The Second Sea Lord became the Deputy Chief of the Naval Staff, responsible for the Operations, Mobilization and Intelligence Divisions and well as the Signals Section and the Third Sea Lord became the Assistant Chief of Naval Staff, responsible for the Trade, Anti-submarine Warfare and Minesweeping divisions as well as the newly formed Convoy Section.[100]

The Convoy Section of the Trade Division was established at the Admiralty on 25 June, with a staff of 10 officers. In September of 1917, the section became the Mercantile Movements Division of the Naval Staff, with a significantly larger staff and no longer reported to the Trade Division.[101] The Director of Mercantile Movements (Captain F.A. Whitehead, R.N.) was responsible to the Assistant Chief of Naval Staff. Mercantile Movements worked closely with the Naval Intelligence Division and with the Convoy Section of the Ministry of Shipping, its civilian counterpart. The Convoy Section of the Ministry of Shipping was responsible for the employment, destination, cargo and bunkering of all ships requiring escort. The Mercantile Movements Division was responsible for allocating the escorts, controlling the movements of the convoying ships from the their ports of assembly to their destinations, assigning routes, directing

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[98] Bowling, 98.

[99] Arthur Jacob Marder, From the Dreadnought to Scapa Flow, Vol IV (London: Oxford University Press, 1969) 174.

[100] Marder, 175-176.

[101] Marder, 263-264.

passage, and giving orders for dispersal to avoid dangerous areas. The Intelligence Division gave up to date information on the location and movement of U-boats.[102]

On 21 May 1917, the Admiralty adopted universal convoying for all merchant shipping.[103] Convoying immediately began to prove its worth. In the two-week period prior to the first convoy sailing to Scandinavia, 114 vessels had sailed along the route, of which 38 vessels or 33 percent of the vessels were sunk. In the two-week period after the adoption of universal convoying, 331 ships sailed under escort, of which only five were sunk. More significantly, roughly the same numbers of U-boats were patrolling in the area during both time periods.[104] The convoy had the added benefit of encouraging trade and removed the advantage of the offensive from the submarine attack. To attack a convoy was to come across a prepared and armed enemy, so despite German High Command exercises to develop tactics to attack convoys, U-boats avoided convoys in favor of other targets.

Though the Admiralty endorsed universal convoying, it never became a reality before the end of the war, and there were still several independently sailed vessels for U-boats to attack. Convoys were only approved for vessels that traveled at speeds between 9 to 20 knots. A few convoys were approved for slower vessels traveling 7-8 knots.[105] From February 1917 to October 1918, 84,545 ships convoyed across the Atlantic, of which, only 263 were sunk by U-boats. Of the 48,861 ships that sailed independently during the same time period, 1,497 were sunk. That means that independently sailing vessels accounted for 85.5% of all shipping losses after convoying was instituted, which was greatly disproportionate considering that independently sailing vessels constituted only one third of all ocean-going traffic during the same time period.[106]

Many factors contributed to the Allied victory during WWI, but it is fair to say that the success of the convoy system was a great contributor. It allowed Great Britain to receive the materials it needed to maintain the war effort. *The Economist* of London editorialized that "Britain has come within very little of losing the war . . . . If the losses

[102] Marder, 264 –266.

[103] Bowling, 177-181.

[104] Bowling, 183-184.

[105] Marder, 270.

[106] Bowling,. 183-184 and Appendix F.

of the British and Allied shipping had continued at the rate recorded for April, May and June 1917, the Germans would have won the war before the year closed".[107] One could argue that the Admiralty was forced to adopt the convoy system because of the gravity of the situation. However, one cannot overlook the importance of the reorganization of the Royal Navy. The reorganization forced the navy to accept and focus on convoying as a solution to merchant shipping losses. The creation of the Mercantile Movements Division and close coordination between Naval Divisions, particularly the Naval Intelligence Division was an organizational innovation that saved mercantile shipping and allowed the British army to fight another day.

E. 1918 GERMAN SPRING OFFENIVES

The past three case studies have presented militaries that innovated organizationally and were remarkably successful. However, not all organizational innovations are successful, and poorly organized forces can prove disastrous. The final case study presented explores a military that innovated purely organizationally, and failed. Leaders who did not fully embrace organizational innovation hindered General Erich Ludendorff's storm troop squadrons in their efforts during the 1918 German spring offensives in WWI.

In January 1918, the German High Command decided to take advantage of a fortuitous set of circumstances. Russia had withdrawn from the war and settled with Germany and her allies. This gave the Germans two advantages: for the first time since the beginning of the war, they controlled more divisions of men than their opponents and many divisions were now free to join the effort on the Western Front. America had joined the war a few months earlier, promising millions of troops to reinforce the Allied effort. However, there was a delay between the promise of troops and the delivery of them, as those troops needed to be drafted and trained. The High Command decided to take advantage of this opportunity to switch from the strategic defensive to the strategic offensive.

Early in the summer of 1916, the German army captured a French document entitled "The Attack in Position Warfare". It's author, Captain André Laffargue, called

[107] Bowling, 98.

for infiltration tactics to be used by *groupes de tirailleurs*, troops armed with semi-automatic weapons. Their goal was to infiltrate the defensive zone as deeply as possible. Artillery bombardment during these efforts would be strong and cover the entire battlefield. The idea behind the new offensive tactics was to attack where the enemy was weakest and follow up successes, not reinforce defeat by becoming a battering ram against strong forces. If an obstacle was strong, forces would simply go around it. The pace was to be determined by the fastest troop, not the slowest. Commanding officers would have to resist the temptation to reform their troops after every obstacle, and instead allow uneven advances.[108] The new tactics were enticing to General Erich Ludendorff, Third Army Supreme Commander, because they promised results that not yet been achieved in the course of the war, and depended on the same weapons used on the Western front for the last two years.[109]

The German contribution to these new assault tactics was to pair them with a new organization. They developed and trained *Stosstruppen* (Storm troops), ten or eleven man units armed with light machine guns, trench mortars, grenades and flamethrowers which were to be the backbone of the effort. The *Stosstruppen* were then organized into 70 attack divisions (*Mob. Divisionen*), which were separate from the regular, less well equipped divisions (*Stellungsdivisionen*).[110] In order to insure that his leadership, company and battery commanders in particular, understood the dynamics of the new organization and tactics, Ludendorff organized a series of one month long schools in September 1916 (*Feld-Kriesschulen*). Special training courses, held at Solesmes, were offered to General Staff officers and front commanders. Nine schools were established to teach new artillery tactics. It is unknown how many officers and non-commissioned officers went to these schools, but historians assume the attendance was high.[111] The next two years were spent training and waiting for the appropriate time to use the new strategy and organization.

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[108] DJ Goodspeed, Ludendorff: Genius of World War I (Boston: Houghton Mifflin Company, 1966) 243-244.

[109] Goodspeed, 243.

[110] Holger H. Herwig, "The Dynamics of Necessity: German Military Policy during the First World War", Military Effectiveness, Allan R. Millet and Williamson Murray, ed. 101.

[111] Herwig, 101.

The first operation of the strategic offensive campaign was code-named Michael. General Erich Ludendorff, who was to command the campaign, favored attacking the sector between Arras and St. Quentin in France. This was one of the weaker sectors, under the command of General Sir Hubert Gough, of whom it was euphemistically said that his "reputation was not for thoroughness".[112] He was in command of the Fifth Army, the smallest of General Douglas Haig's four armies, which had been depleted during the Passchendaele offensive and had not fully recovered by 21 March 1918. It was also the dividing point between the French and British armies, which Ludendorff felt he could exploit.

At 4 a.m. on 21 March 1918, soldiers of the British Fifth Army awoke to a barrage of shelling, smoke, grenades and poisonous gas. At 9:15 a.m., after British troops were sufficiently shell-shocked, German troops advanced. By nightfall, the entire forward position over a stretch of nineteen miles had been lost. On 27 March, the offensive reached Montdidier, a penetration of 40 miles into the enemy territory. It was then that the offensive began to derail. Due to a lack of command and control, German troops had taken to looting the countryside when they saw the bounty available. Also, not all of Ludendorff's commanders embraced the new storm-troop tactics. General Below clung to more traditional tactics and caused many ill-afforded casualties. According to Captain B. H. Liddell Hart, Royal Army, Ludendorff "had sufficient receptiveness to see a new truth, but not sufficient elasticity or conviction to carry it out fully in practice".[113] This was in reference to his support of General Below's attack of Arras, one of the more heavily defended areas. Instead of bypassing Arras, as Storm-troop tactics would have him do, General Ludendorff gave General Below six reinforcement divisions to break through this problem area. This began a trend of Ludendorff's to spend more troops than he had budgeted for each phase of his campaign.

After Operation Michael ceased to gain further ground, Ludendorff launched Operation George.[114] On 9 April 1918, the German army attacked again in Flanders, on

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[112] John Keegan, The First World War (New York: Alfred A. Knopf, 1999) 395.

[113] B.H. Liddell Hart, The Real War 1914-1918 (Boston: Little, Brown and Company, 1930) 400.

[114] Because of the lack of manpower and supplies and the general pessimism of the German officer core, Operation George was informally renamed Operation Georgette.

the coastline of the Lys River, using the same tactics as Operation Michael. The objective was to secure the coastline of the English Channel behind Ypres, and force the British army to evacuate across the channel. After blanketing the area with artillery and poisonous gas for several hours, the German army forced a tired Portuguese division to give up three miles of territory. Ludendorff's army captured Mt. Kemmel and Scherpenburg by 29 April, which were about 15 miles inland from the river.

Ludendorff had expended more troops than he expected in Operation Michael, which forced him to scale back Operation George. He then again spent more troops than he could afford, loosing 110,000 troops in Operation George. Though he was gaining ground in each case, the reserves that Ludendorff could draw from were diminishing rapidly whereas American reinforcements were beginning to fill the Allied lines.

Ludendorff attempted two more offensives, one of on the Chemin des Dames Ridge, where four French divisions and three English divisions came against forty-one divisions of the German crown prince's army. After bombardment early in the morning of 27 May 1918, the German forces managed to gain 30 miles, positioning themselves a mere 56 miles away from Paris in five days. However, the German army quickly outran their artillery and supplies and fell once again to looting the countryside. The 9 June attack on the Montdidier-Noyon sector of the Marne was anticipated, and the German forces met tough resistance. The last significant offensive failed to reach the successes seen by the other three offensives, as the German army had lost the element of surprise. On 11 June 1918, Ludendorff was forced to suspend the offensive. From then on, the German forces were too depleted to launch another successful attack.[115]

One could argue that defeat was inevitable for the Germans. They were depleted of men and resources and the threat of massive American reserves loomed on the horizon. However, the Ludendorff offensives failed before massive numbers of American troops reached the European mainland. The offensives failed for a number of reasons such as lack of supplies and weapons and overextended troops, but mostly because Ludendorff did not completely institute and follow his innovational strategy. Ludendorff squandered his reserves trying to break through heavily fortified areas instead

[115] Liddell Hart, 405.

of flowing around and attacking the weaker points. When the German Eighteenth Army had broken through the Allied Defense, Ludendorff held them back in and attempt to keep them even with Below's troops. It was when Ludendorff fell back on the tactics that had failed earlier in the war and failed to exploit his organizational innovation that his offensives finally failed.

F. CONCLUSION

Overall, militaries that innovated using pure organizational innovation fared rather well. Even the failed Ludendorff offensives gained significant ground before being repulsed. It is ironic to think that most of the militaries with the resources to do so, such at the British Navy in WWI, attempted technological innovation before attempting organizational innovation. The militaries that did not attempt technological innovation of any sort before organizational innovation, such as the Boers and German Army during WWI, only did so because they knew that technological innovation was not an option.

Professor Sir Michael Howard is quoted as saying that "psychological change always lags behind technical change".[116] Likewise, organizational innovation lags behind technological innovation. While this seems to be a natural tendency, it is not a rule as the previously discussed cases show. One simply has to create an environment where innovative thinking is encouraged. Admiral Nelson was well known for maintaining a good rapport with his junior officers. However, the French Army during the interwar period actively discouraged independent thought, as demonstrated in the previous chapter. The result was a military with no organizational innovation.

This chapter has also shown the ability a few well-placed people in the right place at the right time to effect great changes that greatly improved their forces effectiveness. Nelson's innovation organization of his fleet was influenced by a few naval philosophers, but was for the most part, a single person effort. Lloyd George received support from politicians and members of the military, but the reorganization of the Admiralty was his directive. What is most impressive about pure organizational innovation is the relatively small amount of time and resources it requires to create effective innovation.

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[116] Cited in Keegan, The First World War 52.

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IV. ORGANIZATIONAL AND TECHNOLOGICAL INNOVATION

A. INTRODUCTION

This chapter will explore case studies of militaries that innovated both organizationally and technologically. The cases that will be explored are: the German army during the interwar period of the 1920's and 1930's with respect to its development of panzer divisions, German submarines during the same time period, the French naval Jeune École of the 19th century, American amphibious forces during the interwar period, and the recent American campaigns in Afghanistan.

Three of the case studies presented are from the interwar period of the 1920's and 1930's. It is possible that the intense political environment of this period between world wars, when all nations knew that another major conflict was looming on the horizon, inspired militaries to take more risks. Certainly, Germany, which had been economically, militarily and morally crushed by the impositions of the Versailles Treaty in the 1920's, had little to lose. This desperation would explain the drastic innovation the German military undertook in the interwar period. If technological innovation alone proved to be marginally successful, and organizational innovation was generally more successful than not, would the combination of the two provide maximum benefits? On the flip side, would the failure of such a strategy be even more devastating than the failure of organizational innovation alone or technological innovation alone?

It is unlikely that militaries will innovate technologically and organizationally simultaneously. Usually, one form of innovation will lead the other, the first creating the demand for the second. Sometimes militaries advance technologically first, creating new technology and then considering new ways of employing said technology: new tactics, new operations and new strategy. Eventually the new strategy creates a demand for organizational innovation to become fully effective. This bottom-up approach is popular in many militaries. Other times, organizational innovation comes first, and technology is required to follow. Therefore, the mini-case studies will be presented in this manner: first the militaries that innovated technologically and then organizationally will be examined; then the militaries that innovated organizationally and then technologically will be

examined. The next three cases will be the German *Panzer* divisions during the interwar period, the German wolf packs during the same time and American Special Operations forces in Operation Enduring Freedom.

B. GERMAN ARMORED DIVISON

At the end of WWI, the German military was severely downsized. The Treaty of Versailles limited the German army to ten divisions: three cavalry and seven infantry with a combined total of 100,000 troops by 31 March 1920. The German High Command was dissolved and replaced by a less powerful body known as the *Truppenamt*. All war material manufactured was to be reported to and controlled by a committee of representatives of Allied nations. Article 171 of the treaty strictly prohibited: "The manufacture and the importation into Germany of armored cars, tanks and all similar constructions suitable for use in war….".[117] However, that did not prevent the German military from discussing tank tactics and creating a doctrine concerning the use of tanks.

Most military theorists at the end of WWI agreed that tanks were to become a vital platform in future warfare. The German military leadership was no different. Lieutenant Ernst Volckheim was one of German military tacticians who studied tank doctrine.[118] His work would influence most of the tank officers in WWII. His thoughts on anti-tank warfare and the need for radios in all tanks so that tanks could communicate not only with each other, but also with infantry and artillery units influenced the development of Blitzkrieg. Before the rise of Hitler, General Hans Von Seeckt, who served as chief of the *Truppenamt* until 1926, ordered that each unit designate an armor officer and insisted that mock tanks be included in military maneuvering.[119] Though the mock tanks were often canvas and wood structures mounted on bicycles or steel

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[117] The Treaty of Versailles. 10 March 2002 http://history.acusd.edu/gen/text/versaillestreaty/ver159.html (29 April 2002).

[118] James Corum, The Roots of Blitzkrieg (Lawrence, Kansas: University Press of Kansas, 1992) 126-130. Lieutenant Volckheim wrote several articles for Militär Wochenblatt, a newspaper that covered military issues. He also published a book, The Tank in Modern Warfare, that became the basic textbook for all German tanks officers and the foundation of blitzkrieg doctrine.

[119] Corum, 133.

structures mounted on automobiles, Germany was designing and building a small number of real tanks secretly.[120]

German military leadership in the 1920's and 1930's believed there would be roles in future wars for two types of tanks. The first would be a light tank with an armor piercing guns (37mm) and two machine guns. The other would be a medium tank, not to exceed 24 tons, with a large caliber gun (75mm) and two machine guns. All tanks had a speed requirement of 25 m.p.h.. By 1933, all requirements for German tanks could be met, except their need for wireless communication.[121] This capability was necessary for command and control centers to maintain contact with tanks, and avoid the situation that occured with *Stosstruppen* in the previous war, where the troops' discipline dissolved once they were out of range of headquarters command and control.

Historians James Corum and Robert Citino agree that Heinz Guderian's role in tank development in the 1920's and 1930's is often over-emphasized as a result of his publication of Panzer Leader, Guderian's account of armored warfare development in the German army.[122] Guderian's main contribution to armored warfare, according to Citino, was the creation and organization of Panzer divisions.[123]

The rise of Adolf Hitler accelerated the tank development and its associated organizations. His goals of German re-unification were even more expansive than the goals of the previous Weimar governments and he was in favor of military technology and organization that promised quick results.[124] In July 1934 a Tank Forces Command (*Kommando der Panzertruppen*) was established, with Heinz Guderian serving as Chief of Staff. The command was charged with continuing organizational and tactical experiments with armored forces. The command also continued design work on the tanks themselves. Designs were approved and orders were placed for the creation of *Panzerkampfwagen(s)* II, III, and IV by 1934, 1935, and 1936 respectively. These were

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[120] Heinz Guderian, Panzer Leader (Washington D.C.: Zenger Publishing Co, Inc., 1952) 27-29.

[121] Guderian, 27-28, 32.

[122] Robert Citino, The Path to Blitzkrieg (Boulder, Colorado: Lynne Rienner Publisher, 1999) 201-202. Corum, 138.

[123] Citino, 230-232.

[124] Barry R Posen, The Sources of Military Doctrine (Ithaca, New York: Cornell University Press, 1984) 181.

the tanks that the German command would have in the field when WWII began three years later.

After successful large-scale armored maneuvers at Münsterlager in the fall of 1935, the first three panzer divisions came into existence in October 1935.[125] Each panzer division had two tank regiments of two battalions each, with 128 *Panzerkampfwagens I* per battalion. Including command tanks, each panzer division had a total of 561 tanks. There were also two battalions of motorized infantry, one motorcycle battalion, a motorized artillery regiment, a motorized antitank battalion, a motorized pioneer battalion and a motorized reconnaissance battalion. According to Richard Ogorkiewicz, a panzer division was "a self-contained combined arms team in which tanks were backed up by other arms brought up, as far as possible, to the tanks' standards of mobility".[126] The importance of combined arms was emphasized in German doctrine as early as the 1920's when General Von Seeckt insisted that cadets and general staff officers be trained in and familiar with all branches of the Army. Dominick Graham, scholar of British armored doctrine, believed that the German ability to combine tanks, guns and armored troops was critical to their success in northern Africa.[127] This innovational organization is what separated the Germany panzer divisions from its contemporary British and French counterparts. It allowed for the remarkable success of Blitzkrieg.[128]

By 1940, elements of the German military had created a new doctrine, which became known as Blitzkrieg in western nations. Blitzkrieg emphasized speed and mobility over firepower, though at decisive points, it aimed for a concentration of firepower using tanks, dive bombers, anti-tank and anti-aircraft weaponry. Aircraft were used both offensively and defensively to prepare the way for advancing armor units. Like WWI doctrine, storm troop tactics were used. Unlike WWI doctrine, military forces aimed to disorient the enemy's command structure as much as it sought to destroy enemy troops. To this effect, the doctrine encouraged deep penetrations into the enemy's rear

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[125] Citino, 230.

[126] Richard Ogorkiewicz, Armoured Forces (New York: Arco Publishing, 1970) 73.

[127] Shelford Bidwell and Dominick Graham, Fire Power: British Army Weapons and Theories of War, 1904-1945 (London: George Allen and Unwin, 1982) 224-233.

areas. Another improvement was the installation of radios in all tanks. During the Ludendorff offensives at the end of WWI, troops quickly lost all discipline as soon as they were out of communication with senior leadership. Blitzkrieg maintained discipline and allowed senior leaders to give guidance once objectives were reached.

At the battle of France, the Germans had 1445 Panzerkampfwagen I's, 1238 Panzerkampwagen II's, and several hundred more modern versions of the Panzerkampwagen for a total 3862 tanks, compared to France's 4688 tanks.[129] The average German tank on the Western front had a speed of 26.5 m.p.h. and a range of 110 miles compared to 20.1 m.p.h. and 89 miles, the average speed and range of French tanks on the same front.[130] Despite their numerical inferiority in tanks, the Germans had the advantage in combined arms firepower, bringing 2,600 88-mm flak guns and 6,700 light flak guns against France's 1,500 flak guns of all types.[131] The immediate success of blitzkrieg is uncontested. The capture of Poland in four weeks and defeat of France in six weeks attest to its strength. At the Battle of Sedan (14 May 1940) five panzer divisions overwhelmed four French armored divisions. On the morning of 14 May 1940, fifty French tanks were destroyed on the battlefield, with minimal German losses.[132]

Blitzkrieg doctrine looked at available modern technology and sought to maximize its potential. While new tanks and aircraft were designed throughout the war, the doctrine was developed to fit the most modern technology available. Likewise, the organizations of panzer divisions were continually adjusted according to the needs of campaign and available technology.[133] This is an example of extremely successful bottom-up approach to military innovation. As the technologies that could be exploited

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[128] Citino, 243-244.

[129] R. H. S. Stolfi, "Equipment for Victory in France in 1940," History Vol. 55, No. 183, 6-8.

[130] Stolfi, 14.

[131] Stolfi, 203.

[132] Friedrich Wilhelm Von Mellenthin, Panzer Battles (Norman, Oklahoma: University of Oklahoma Press, 1956) 12-17.

[133] "*Panzer Divisionen*" 17 May 2002 http://www.feldgrau.com/heerpa.htm (09 June 2002). This website documents 36 separate panzer divisions, their organizational and battle history throughout the course of WWII. All panzer divisions underwent some organizational revision as the technologies that were available fluctuated through out the course of the war.

fluctuated, the German military adjusted their doctrine and organization to maximize their potential effectiveness.

C. WOLF PACKS

Another example of bottom-up interwar innovation is found within the German navy. The navy had found relative success with submarines employed in commerce raiding during WWI. The traditional navy didn't fare as well, making only one major appearance at the Battle of Jutland, which was at best a draw. Toward the end of WWI, submarine sorties became less effective because of the newly adopted policy of convoying merchant vessels. The German High Command experimented with different tactics to overcome the new threat posed by convoys, including attacking a convoy with several submarines at once.[134] While this strategy wasn't adopted before the end of the war, it did catch the attention of then LCDR Karl Dönitz, who was to become ADM Dönitz, Submarine Force Commander and the father of wolf pack organization and tactics.

The Versailles Treaty stipulated that Germany surrender all U-boats at "ports specified by the Allies and the United States" and scuttle any vessels that were not sea-worthy.[135] The German Navy continuously tried to subvert the terms of the agreement, with some success. Though attempts to hide U-boats after the treaty were unsuccessful, the German Navy did found the German Submarine Construction Office in April of 1922 under the cover of the Dutch company NV Ingenieurskaantor voor Sheepsbouw. In this manner, senior naval leadership kept abreast of the most recent developments in submarine technology.[136] Similarly in violation of the Versailles Treaty, Mentor Bilatz, a quasi-private shipbuilding company built and tested German naval submarine designs by selling them to other nation's navies, such as Japan, Turkey and Finland.[137] A great volume of information was collected in that manner and prompted *Reichwehrminister*

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[134] Roland Bowling, CAPT USN (Ret), "The Negative Influence of Mahan on the Protection of Shipping in Wartime," Diss. University of Maine, 1980: 243.

[135] V.E. Tarrant, The U-boat Offensive 1914-1945 (Annapolis: Naval Institute Press, 1989) 77.

[136] Tarrant, 78.

[137] David Miller, U-boats (Washington D.C.: Brassey's, 2000) 16-17.

(prime minister) Kurt von Scheicher to approve a plan to build 16 U-boats on 15 November 1932.

The following January, the National Socialists came into power and escalated military plans. Hitler's repudiation of the Treaty of Versailles on 16 March 1935, led to a new naval agreement with Great Britain that allowed Germany to construct a submarine force of 45% the mass tonnage of British submarine forces with provisions that allowed Germany to construct submarine force equal in mass tonnage to British submarine forces should "special circumstances" arise.[138] Despite this provision, the German Navy only had 57 available U-boats at the start of WWII because of Hitler's decision to give preference to the rearmament of the army over the navy and the navy's expenditures on conventional surface ships.

The most common U-boat during WWII was the Type VII, of which 709 were commissioned before the end of the war. The most common variation, the Type VIIC displaced 865 tons submerged, had a surface speed of 17.2 knots and a submerged speed of 8 knots, a surface range of 9,700 nautical miles (nm) on the surface and 90 nm submerged, had a diving depth of 328 ft, a crush depth of 656 ft and carried 14 torpedoes. Though its performance was not outstanding in any field, its all-around durability made it a valuable platform. These platforms were a gradual improvement from their WWI ancestors, larger, faster, with more endurance, larger payloads and better communications ability. Several truly innovative U-boats were developed during the war years, such as the Type XXI which was the first contemporary submarine, a vessel faster and more maneuverable underwater than on the surface due to its' streamlined hull design.[139]

In the summer of 1938 Admiral Dönitz outlined the basis structure of the wolf pack, writing that the "essential effect against a gathering of steamers in convoy can only be realized when a great number of U-boats can be successfully set on the convoy . . . . This is conditional on the U-boat [that is] in touch with the convoy calling up the others

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[138] Tarrant, 78.

[139] Miller, 60. Type XXIII submarines were to have revolutionary hydrogen peroxide powered engines that were air-independent. However, due to the constraints of the war, it was suggested that the hull design of the XXIII be used with conventional engines and thus, the XXI was created. Of the 120 XXI submarines built, but only two had participated in operational patrols before the end of the war.

[U-boats]."[140] Radio communications were to be central in wolf pack organization. Unlike the Battle of Jutland, the new organization of the German submarine force depended on the new information technology. Because the wolf pack needed radio communications to make decisions, it was effectively used. The inspirations for wolf pack tactics were several failed experiments by the U-boat command in the spring of 1917. The experiments attempted to coordinate several U-boats to attack a convoy at once, using radio communication.[141] Admiral Dönitz was convinced that Great Britain would re-institute convoying once it perceived that unrestricted U-boat warfare was being used against it. To counter this, he had two plans: to engage in aggressive but restricted warfare for as long as possible and to employ the newly developed wolf-pack organization and associated tactics. The first plan, to engage in aggressive but restricted warfare, did not last long, as *U-30* torpedoed the British passenger liner *Athenia* on 3 September 1939 when the captain of the U-boat misidentified it as a troop transport vessel.[142] Having anticipated the return of U-boat *geurre de course,* the Admiralty quickly re-instituted convoying.

The first attempt at wolf pack organization on 17 October 1939 was unsuccessful. Nine boats were deployed to attack HG3, with *Korvettenkäpitan* Hartmann, Chief of the 6th Flotilla on board *U-37* acting as the wolf pack commander. Of the nine boats that were sent to attack convoy HG3, only three actually made it to the convoy itself. There were problems with malfunctioning torpedoes and it was determined that designating a commanding officer who traveled with the wolf pack was not an effective command and control mechanism.[143] In response to these disappointing results, an inquiry was launched into torpedo production and the wolf pack organization was refined. In the year between the first and second attempts at wolf pack organization and tactics, the U-boat force supported military operations in Scandinavia and targeted independently traveling ships.

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[140] Tarrant, 80.

[141] Bowling, 185-187.

[142] Miller, 125.

[143] Tarrant, 82.

On 2 August 1940, Lorient became operational as the first of several U-boat bases on the coast of Biscay in France. This meant that range of U-boats was extended several hundred miles, as vessels did not have to return to bases in Germany.[144] Admiral Dönitz decided to centralize all U-boat operations in the U-boat head quarters of Chateau Kernival in Brittany.[145] The goal of the wolf pack was to "locate the enemy, report his position and to attack him with the greatest number of U-boats".[146] U-boats would patrol in a designated area of the ocean, where intelligence indicated that convoys might be passing through. Once a U-boat found a convoy, they were to radio their position and the convoy's position to U-boat HQ in Lorient. Dönitz would then alert all U-boats in the area of the convoy's presence. Dönitz felt that the benefits to be gained from centralized coordination and organization would outweigh the threats of radio directional searches that breaking radio silence would incur.

Wolf pack organization was remarkably successful. When enough U-boats could be mobilized to attack a convoy, the results were deadly. Convoy HX72 lost 11 ships and another two were damaged, resulting in a loss of 72,727 tons of shipping on 21/22 September 1940. Convoy SC7 lost 20 ships in October of the same year, and HX79 lost 12 ships in the same month.[147] Forty three percent of ships that began a convoy in the months of November 1940 to March 1941 did not reach their final destination.[148] In 1942, the average monthly sinking rate of ships was 512,456 tons a month.[149] Admiral Dönitz estimated that 900 thousand tons of shipping would have to be sunk each month to overwhelm Allied ship building capabilities. This was never achieved, partly because a very small number of U-boats were actively patrolling at any time compared to WWI and partly because Allied submarine detection technology outpaced German counter-detection technology. Once the Naval Enigma codes were broken, the Allies knew the location of every U-boat in the fleet and could attack them rapidly. The centralized

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144 Bowling, 369.

145 John Barratt, "The U-boat War, the climax, July 1942- May 1943," Military History Online http://www.militaryhistoryonline.com/wwii/atlantic/climax.asp, (29 April 2002).

146 Karl Dönitz, Ten Years and Twenty Days (Cleveland: World Publishing Company, Ohio, 1959) 19.

147 Tarrant, 91.

148 Tarrant, 93.

149 Tarrant, 111.

control of the U-boat service helped the Allies in their information gathering efforts. By 1943, Admiral Dönitz had temporarily cancelled all U-boat operations in the Atlantic.

The U-boat campaign was an example of a moderately successful military innovation involving both innovative technology and organization. However, some of the new technology eventually betrayed the organization. According to historian David Kahn, the Enigma coding machine was vital to U-boat operations and its compromise doomed the organization.[150] The wolf pack organization operated under the premise that the U-boat would be undetected until it was in range to attack, which was true while wolf pack attacks were successful. When Allied detection technology outpaced German counter detection technology, the wolf pack became the hunted as opposed to the hunter. What this case suggests is that an organization that outpaces the technology available is equally as ineffective as technology that outpaces the organization. Unbeknownst to Dönitz, he had created an organization to maximize the effective of his U-boats and found that the organization he had designed required technological innovation not in hand.

D. OPERATION ENDURING FREEDOM

Another, more recent example of organizational and technological innovation are recent American operations in Afghanistan. While the WWII era examples focused on using technology to mass personnel and firepower on target, the more modern variations of this type of combined innovation have used technology to distribute forces while still massing firepower on target. This case may not be as complete as the previous cases because the situation is on going and some of the information is closely guarded. Also, hindsight is 20/20, some information contradicts itself and will only be clarified through the perspective that times brings.

The 11 September 2001 attacks caught America by surprise, as the nation had felt impervious to attacks on its homeland. Al-Qaeda's networked organization had been designed to subvert America's strengths as a military power and exploit its weaknesses as an open society. Al-Qaeda operatives used portable satellites, Internet communications, cryptography, steganography and other advanced technologies. After determining that

[150] David Kahn, Seizing the Enigma (Boston: Houghton Mifflin Company, 1991) 47-48.

Al-Qaeda was sheltered and aided by the ruling party of Afghanistan, military retaliation began.

Futurist Alvin Toffler claims that American is currently poised on the cusp between Second Wave and Third Wave civilizations. Second wave civilizations are defined by industrialization, the standardization of products, routines and education and the centralization of power. Third Wave civilizations take advantage of improved information technologies to break down large bureaucracies and disperse information. The ability to communicate over long distances and the gradual shift of the economy from a production-based system to a service-based system allows people to spread out, and become more independent. This lack of proximity to specialists will also prompt the return of "the-jack-of-all-trades" and workers who are skilled in more than one area. In the same manner, modern military operations have followed suit, which is especially clear in Operation Enduring Freedom.[151]

On 7 October 2001, Secretary of Defense Donald Rumsfeld announced the beginning of Operation Enduring Freedom, while US warplanes were attacking key infrastructure and communications nodes.[152] Operation Enduring Freedom began in what political consultant Dick Morris calls the "Clinton Doctrine that kept military efforts airborne and barred the use of ground troops…until after the aerial bombardment had neutralized the enemy."[153] After a few weeks of strategic bombing returned little in the way of new information or concessions by the Al-Qaeda and Taliban leaders, the operation gradually shifted to the "Rumsfeld doctrine". The Rumsfeld doctrine stresses coordination "among native ground power forces, U.S. Special Forces and commandoes, and American air power."[154]

Ground troops working in small units joined forces with Northern Alliance soldiers and participated in small, packetized attacks. The attacks used a strange

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[151] Alvin Toffler, The Third Wave (New York: Morrow, 1980) 20-25.

[152] Rumsfeld, Donald, SECDEF, "Address to the Troops and All Department of Defense Personnel at the start of U.S. and coalition air attacks on Taliban-held and terrorist targets in Afghanistan," Defense Link. 7 October 2001. http://www.defenselink.mil/specials/secdefaddress2/, (10 May 2002) 1.

[153] Dick Morris, "The Rumsfeld Doctrine," The Hill 9 January 2002 http://www.thehill.com/010902/morris.shtm., (12 May 2002) 1.

[154] Morris, 1.

combination of high tech and low-tech gadgetry. Deputy Defense Secretary Paul Wolfowitz presented the following except from a U.S. ground troop's letter at the Fletcher Conference: "I am advising a man on how to best employ light infantry and horse cavalry in the attack against Taliban T-55s (tanks) ... mortars, artillery, personnel carriers and machine guns -- a tactic which I think became outdated with the introduction of the Gatling gun."[155] The American forces that rode horses with the Northern Alliance were Army Special Forces, known as green berets. They are organized into twelve man units, with one officer and eleven senior enlisted personnel. Like the Toffler's third wave jack-of-all-trades, members of the green berets are trained in weapons, communications, foreign languages, combat engineering and combat medicine.[156] The Northern Alliance is a closely linked association of several warlords, each of whom commands the loyalty of several thousand guerrilla fighters. The organizational innovation was not in the either the Northern Alliance or the Special Forces community, but in the collaboration between the two. In recent American military engagements, either large numbers of forces were established on the ground in the area of operations (such as Vietnam or the Gulf War) or no forces were established on the ground at all (retaliatory strikes against Iraq and Kosovo). By sending a small number of troops into Afghanistan, the U.S. military struck the balance between having no ground support and supporting a large military operation. Unlike Somalia, American forces were integrated with Afghan forces as opposed to associated with Afghan forces. This integration allowed for the introduction of American technology and air power into many of the Northern Alliance actions and allowed American forces to guide the Northern Alliance in missions that were important to American interests.

After three weeks of operations with ground troops, Rear Adm. John Stufflebeem announced at a Pentagon press conference that friendly forces controlled two thirds of

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[155] Jim Garamone, "Wolfowitz Shares Special Forces' Afghanistan Dispatches," American Forces Information Service 15 November 2001. http://www.defenselink.mil/news/Nov2001/n11152001_200111155.html, (12 May 2002).1.

[156] David Tucker, "War in Afghanistan and American Character," On Principle April 2002 http://www.ashbrook.org/publicat/onprin/v10n2/tucker.html (10 June 2002).

Afghanistan.[157] By the beginning of December, a number of Taliban and Al-Qaeda fighters were in US custody.[158]

At the same time, Operation Enduring Freedom has validated the Predator missile, which made news by being the first independently launched (i.e. launched from platform where no human input was possible) missile. On 27 Feb 2002, the Air Force's Predator unmanned aerial vehicle successfully aimed and fired a Hellfire-C laser guided missile at a stationary target and allegedly proved the viability of this option.[159] Earlier exploratory tests had been conducted at Indian Springs, Nevada on 16 and 21 February 2001.[160] Previously, Unmanned Aerial Vehicles (UAVs) had been used solely for surveillance reasons, due to the desire to maintain a "human in the loop" in stressful situations where experienced pilot judgment might be necessary. These tests came at the urging of CIA officials who were frustrated with the time delay between surveillance taken by the Predators indicating a viable target and the prosecution of said target. Often, this delay meant the loss of targets of opportunity. Other innovative technologies used were laser-guided munitions, heat signature readers, GPS and portable satellite communications.

This is clearly a case of technological innovation leading organizational innovation. The U.S. military was frustrated that their advanced technologies were not yielding the results desired. By allowing the collaboration between U.S. Special Forces and Northern Alliance troops, modern U.S. military technology was more effectively used. Though the Special Operations Forces had been working on the ability to conduct this sort of operation for a while, military doctrine and hence, organization had not allowed it until Operation Enduring Freedom.

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157 John Stufflebeem, Rear Admiral USN, "Enduring Freedom Operational Update," Defense Link 15 November 2001 http://www.defenselink.mil/news/Nov2001/t11162001_t1116stf.html, (12 May 2002) 1.

158 Kathleen T Rehm, "American Taliban Fighter Under U.S. Control in Afghanistan," American Forces Information Service 3 December 2001 http://www.defenselink.mil/news/Dec2001/n12032001_200112033.html, (12 May 2002) 1.

159 Sue Baker, "Predator missile launch test totally successful," Air Force News 27 February 2002 http://www.af.mil/news/Feb2001/n20010227_0283.shtml (12 May 2002) 1.

160 "General Atomics MQ-1 and RQ-1 Predator" Jane's, 29 April 2002 http://www.janes.com (12 May 2002) 2. This is an interesting contradiction. Baker's article, available through Air Force News, on the 21 February launch claimed the experiment was "the first recorded missile launch from a UAV", whereas Jane's, which claims that the same experiment had been performed a year earlier, is also a trusted source.

So far, this seems to be a successful mix of organizational and technological innovation. Within days of small units of Marines being placed in Afghanistan, Taliban and Al-Qaeda fighters were captured and intelligence on senior leaders increased greatly. By successfully integrating small special operations units into indigenous forces and commanding joint air power, the United States has managed to create an organizational innovation that exploits both the most modern technologies and retrograde technology such as cavalry units. This case is a strong indicator that a properly organized force can exploit a wide range of technologies and tactics.

E. JEUNE ÉCOLE

The next two case studies involve militaries that innovated in a top-down manner, first identifying a new role for the military, then creating an organization to assume that role and finally, developing doctrine, tactics and technology for the organization. The French Jeune École was unsuccessful in its attempts to innovate, while American amphibious doctrine was wildly successful.

After the loss of the Franco-Prussian war (1870-1871), the French navy was forced to reevaluate their role in the national security plans. Since the loss of the war, the main threat to their security was Germany, a continental power, not Great Britain, a naval power. The navy had contributed little to the recent war efforts: garrison duty in Paris and an unsuccessful blockade of the German coast.[161] Inspired by the successful blockade of the Confederate coast during the Civil War, the French Jeune École emerged as proponents of a smaller, more mobile navy. The premise of the Jeune École school of thought was that no navy was powerful enough to directly counter the threat posed by the Royal Navy. Instead of attempting a futile race for larger, faster, better ships; a nation could develop an advantage over the Royal Navy by exploiting their weaknesses, namely their dependence on foreign food and raw materials.

The leader of the Jeune École movement was Admiral Hyacinthe-Laurent-Theophile Aube, who was the minister of the Marine from 7 January 1886 to 30 May 1887. The majority of Admiral Aube's time in the Navy was spent overseas, protecting

[161] Theodore Ropp, "Continental Doctrines of Sea Power", Makers of Modern Strategy ed. Earl Edward Mead (Princeton: Princeton University Press, 1944) 446-447.

French colonial interests and which greatly influenced his doctrine. Aube identified three major threats to French interests: Italy, Germany and Great Britain, and proposed different naval strategies for each nation.

It is Aube's ideas for the defense of France against Great Britain that defined the ideas of the Jeune École and became the source of lively debate in the French navy. Great Britain, the traditional enemy of France, could be conquered by ruthlessly attacking British merchant shipping. A large fleet consisting of torpedo boats, gunboats and boats with rams would accomplish this. The common thought amongst officers of the Jeune École was that "the principle vice of the iron-clads is the attempt to combine in them at one time all of the means of naval warfare: the ram, the gun and the torpedo. The result is that they are not really suited to use any of them."[162] A navy of many small vessels would allow the navy to disperse in many directions, but "thanks to steam and the electric telegraph, meet at a fixed hour at a rendezvous assigned to them at the last minute" and ensure numerical superiority.[163] According to historian Theodore Ropp, "No idea in Aube's writings is more important than this claim that it was possible to ensure momentary superiority, even on the High Seas, by a combination of forces from a number of Naval bases."[164]

Since torpedo boats and gunboats (vessels with a single cannon) would be lightly defended, if at all, torpedo boat operations necessarily differed from the conventional laws of maritime war. In order for a torpedo boat to successfully attack its target, it couldn't announce its presence and demand surrender. By attacking at night where poor visibility would disguise the torpedo boat, and using the element of surprise, a small vessel could easily attack a larger vessel and quickly disappear into the night.

Admiral Aube did not reorganize the navy's administration, though he did cause great turnover in senior leadership. He reduce the mandatory retirement age limits, threw out most of the officers on the Navy's Paris staff, and most of the Bureau Chiefs. He

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[162] Theodore Ropp, The Development of a Modern Navy (Annapolis: Naval Institute Press, 1987) 160.

[163] Ropp, Development 157.

[164] Ropp, Development 157.

then requested special credit of 200 million francs for a building program that included six large and ten small cruisers, twenty large torpedo boats, fifty gun-boats, one hundred regular torpedo boats and three armored coast defense ships to use as mother torpedo boats that would shelter and supply the smaller vessels. This program was reduced in size as it made its way through the approval process. The resultant building program included three large cruisers, two medium sized cruisers, six small cruisers and twenty-one torpedo boats.[165]

Unfortunately, the Jeune École's doctrine and its concept of a dispersed organization was more advanced than the technology available at the time. Building "cheap" vessels, the appropriate research and development was not designated and most of the vessels proved to be unseaworthy. In April 1886, Aube ordered the construction of an experimental gunboat named after a close friend, Gabriel Charmes. The *Gabriel Charmes* was a thirty-five meter torpedo boat carrying one 5.5 inch gun. Because of the instability of the platform, the gun's accuracy left much to be desired and was dropped from the building program.

According to the Jeune École doctrine, torpedo boats were to be autonomous. To test this claim, torpedo boat No. 61 set out across the Bay of Biscay in February 1886. The journey was made safely, though the quality of life was not tolerable for more than a few days. Crews suffered from seasickness and fatigue. According to one participant:

> As a rule, we lived on hams, sardines, and tinned soups; for the most of time the weather was so rough that it was as much as we could do to get a little water boiled. We had a table about 18 inches wide, but there was no point in laying it, for nothing would stay on it. The usual plan was for one man to hold the sardine tin while the other picked out sardines by their tails and transferred them to his mouth.[166]

The idea of an autonomous torpedo vessel was also quickly discarded.

Tests did show that torpedo boats were capable of breaking blockades. Torpedo boats surprised the designated blockade runner cruiser 8 times, came within firing range 21 times and made 126 surprise appearances during the course of the experiment.[167] Other positive developments were the design of more effective torpedoes and explosives

[165] Ropp, Development 168.

[166] Ropp, Development 176.

[167] Ropp, Development 176-177.

and the development of first French submersible vessel, which was built after Aube recognized the role for the submarine and awarded a contract for its construction.

The role for the torpedo boat was limited and ultimately disappeared with the introduction of the dreadnought. Similar concepts espoused by the Jeune École reappear occasionally, including the nearly successful German U-boat doctrine during WWI, and the "street-fighter" program of the U.S. Navy. The torpedo boats of the nineteenth century have developed into the versatile modern day destroyers.[168] Like the next case to be examined, U.S. amphibious doctrine, the Jeune École required that technology be developed to fit its doctrine. Unlike U.S. amphibious doctrine, research and development allocated to the new technology was insufficient.

F. AMERICAN AMPHIBIOUS DEVELOPMENT

The development of American amphibious doctrine between WWI and WWII is another example of interwar innovation.[169] In 1919, the United States returned to its isolationist policies. The largest perceived threat to US interests was Japan, due to the United States' role as protector of China and governor of the Philippines. Color-coded war plans were developed, outlining different threats to US interests, with ORANGE designated as the naval plan to cope with the Japanese threat. After 1919 the military services focused on war plan ORANGE to guide force development; because of the broad nature of the plan, each service could justify most of its spending as vital to the prosecution of the plan. In 1920, the Commandant of the Marine Corps, Major General John A. Lejeune, realized the importance of amphibious assaults to the success of war plan ORANGE. A staff officer, Major Earl H. Ellis, USMC, wrote Operations Plan 712 "Advanced Base Force Operations in Micronesia," which Lejeune endorsed as the basis for all future Marine Corps training.[170]

The Marine Corps' focus on the development of amphibious doctrine resulted from a combination of many factors. The Army was constantly threatening to absorb the

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[168] Ropp, "Continental Doctrines" 447.

[169] For a definitive version of this case study, see Branden Little's . His thoughts greatly expand what is discussed here. He also contends that American amphibious doctrine did not become offensive in nature until the creation of the FMF and that the FMF failed to fully exploit the capabilities of the Amtrak.

[170] Jeter Allan Isley and Philip A. Crowl, The U.S. Marines and Amphibious War (Princeton: Princeton University Press, 1951) 25-26.

Marine Corps, and during the Great Depression congressional allocations for the military were scarce. By taking the lead in developing amphibious doctrine, the Marine Corps was creating a permanent role for themselves and assuring their independence as a service. The Navy and Marine Corps attempted their first landing exercise in 1922 with two companies of Marines at Culebra and Guantanamo Bay. The next two exercises were in 1924 and 1925. Because of the various missions assigned to them, Marine Corps leadership found it difficult to focus on amphibious doctrine development. The 1926 offensive landing exercises were extremely limited because the Marines that were to participate in the exercises were instead deployed to guard U.S. mail, and operations in China and Nicaragua.[171]

It became clear that if the Marine Corps did not prioritize amphibious warfare development, they would never develop the capability. Under their current organization, the development of amphibious doctrine would always be a secondary concern. Major General John H. Russell, Assistant Commandant of the Marine Corps, pushed for the creation of the Fleet Marine Force. This force would be included in the naval fleet organization and subject to the orders of the Commander in Chief, U.S. Fleet. His suggestion led to the establishment of a new branch of the Marine Corps, ordered by Navy Department General Order No. 241 on 8 December 1933.[172] The Fleet Marine Force would be maintained in a state of readiness for operations with the fleet and had the specific mission of executing landing operations. They would not be used for garrison duty, counter-guerrilla operations, base defense or the myriad of other missions performed by the Marine Corps.[173]

The creation of the Fleet Marine Force was the catalyst for the rapid development of amphibious doctrine. Commandant of the Marine Corps General Ben H. Fuller explained to his senior commanders that FMF (Fleet Marine Force) development would be the Marine Corps' first priority. It would not do to have a branch of the service without firmly established doctrine and roles for it.[174] In late 1933, when plans for a

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171 Allan Millet, Semper Fidelis (New York: Macmillan Publishing Co., Inc. 1980) 327-328..

172 Isely and Crowl, 33.

173 Millett, 328.

174 Millett, 330.

landing operations manual were disrupted by the lack of personnel due to the mobilization of a Marine regiment for Cuban duty, the Commandant of the Marine Corps Schools recommended that all classes be suspended and that students and faculty dedicate their time to creating said manual.[175] The Tentative Manual for Landing Operations of 1934 eventually became Fleet Training Publication 167 (1938), the doctrine for the conduct of amphibious operations.

In 1934, General John H. Russell was appointed Commandant of the Marine Corps and continued the service's drive to develop the FMF. He reestablished the Fleet landing exercises to test and refine the doctrine established in Tentative Manual for Landing Operations. Many variations of the amphibious assault were investigated: day and nighttime landings, smokescreens, an variety of naval and close air support, concentrated assaults and dispersed infiltration, different weapons, and the use of feints, demonstrations and deception. It was determined that a successful amphibious assault would isolate the target area and bombard the defenders with naval gunfire and close air support. The landing would require a combined arms team to assault the beach over a broad front of over 1000 yards and would need rapid reinforcement with artillery and tanks. Threats to a successful amphibious landing included combined air and naval counter-attacks and a counter-landing effort.

One of the most consistent criticisms of the FLEXs (fleet landing exercises) was the difficulty in transporting all the necessary equipment. In order to transfer men and equipment from larger transport ships to shore, smaller boats with shallow drafts had to be developed. Once they were developed, the boats themselves needed transportation to the theater of operation. While amphibious doctrine was in the final stages of development, appropriate transportation was embryonic.

In 1939, the Navy and Marine Corps tested Andrew Higgins' Eureka boats as possible transport.[176] The shallow draft vessels were designed to travel around the

[175] Kenneth Clifford COL USMCR, Amphibious Warfare Development in Britain and America from 1920-1940. (Laurens, New York: Edgewood, Inc, 1983) 101-102.

[176] Clifford 111-112. Higgins had visited Quantico in 1934 to interest the Marine Corps in his design, but budgetary constraints did not allow the Marine Corps to test the design. In October 1936 Higgins submitted his design to the Department of the Navy, which also could not afford tests. It wasn't until the spring of 1938 that the Navy investigated the possibility of the Higgins boat. In 1939, they ordered 5 to participate in FLEX 5.

Louisiana bayou and were easy to pull to shore and re-launch. They were remarkably powerful, even when enlarged to meet Army specs. In April of 1941, Higgins modified his boats by adding a landing ramp in the bow. This design idea was taken from the Japanese landing boat *Dai-Hatsu*, 14M type.[177] This would not be the only design that the American military copied from the Japanese Navy. In order to transport the Eureka boats, the Navy copied the Japanese design of *Shinsu-maru*, which was the inspiration for modern day LHA and LHD class ships. The *Shinsu-maru* had a well deck, which could be flooded with water. From there, the smaller transport boats could simply float off the ships into littoral areas. The first LST was commissioned in 1942 and the first LSD was commissioned in 1943. Further modifications were made in 1941 so that "Eureka" boats could be accommodated by LSTs (landing ship tank) and LSDs (dock landing ship).

Other technical developments prodded by the development of amphibious doctrine were a larger version of the Eureka, designed to transport tanks ashore. Amphibians, tanks that bridged the gap between where boats could operate and car engines stalled out, were also developed. The "alligator", which became the United State's main amphibian, was developed as a rescue vehicle after financier John A. Roebling was shocked by the devastation of a Florida hurricane.[178] It eventually became the LVT (Landing Vehicle Tracked) that was used throughout the war.

The success of the amphibious campaigns is well known. The island hopping campaigns in the Pacific and D-Day off the coast of Normandy are amongst the famous WWII campaigns. In fact, neither the German nor Japanese militaries ever successfully repulsed an American amphibious operation. The ability to launch a highly organized amphibious assault remains one of the United States operational strengths today.

Several differences are apparent between the two cases that innovated using a top-down approach. The French navy never created a separate organization whose primary task was the development of Jeune École doctrine and technology. Because of this, the French navy remained mired in larger doctrinal arguments and the few experiments performed were hastily planned. The Marine Corps' equivalent to the French naval

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[177] Clifford, 113.

[178] Clifford, 118.

experiments of 1886 were the FLEXs executed in 1922, 1924 and 1925. None of these experiments were overwhelmingly successful either, and tended to emphasize the need for new technology and doctrine. However, with the creation of the FMF, the Marine Corps was able spend the time and effort necessary to develop a successful new amphibious assault capability.

G. CONCLUSION

What the past few case studies have shown is that a combination of technological and organizational innovation can yield enormous results. By innovating both technologically and organizationally, and military incurs greater risk but could also achieve greater results. However, it is important to ensure that technological innovation does not outpace organizational innovation and that organizational innovation does not outpace technological innovation. When the development of technology and doctrine are nearly simultaneous, such as in Operation Enduring Freedom and Blitzkrieg doctrine, the results are quite successful. When technological innovation lags behind, as it did in the development of American amphibious capabilities and German wolf packs, military effectiveness suffers. In the case of American amphibious operations, eventually technology caught up with the FMF and allowed victory. Germany was not afforded to opportunity to allow the technology catch up to their organization and therefore faltered when Allied technological innovation outpaced them. The Jeune École, a prescient naval organization and strategy that was not feasible with its contemporary technology, was partially redeemed by the near success of German U-boat operations during WWI.[179]

Technological and organizational innovation cannot be successful without the support and contributions of many individuals. However, it often seems that most influential person in the creation of a successful organizational innovation receives most of the credit for the success of the whole. For example, Heinz Guderian's main contribution to the Germany military between WWI and WWII was the establishment of the panzer divisions. However, he is often credited with the successes of blitzkrieg doctrine. Likewise, Admiral Dönitz is remembered as the father of wolf pack tactics, when his main contribution was the organization of the U-boat command. While he did

[179] Eugenia C. Kiesling, Introduction, Strategic Theories, By Raoul Castex (Annapolis: Naval Institute Press, 1994) xxvi.

work on wolf packs doctrine and tactics, he was originally inspired by an exercise held by the German High Command in 1918. Futurists such as the Tofflers and analysts John Arquilla and David Ronfeldt have advocated several key aspects of the Rumsfeld doctrine for several years before they were utilized. No combined organizational and technology innovation is ever the work of only one person. This is not to marginalize the role that these individuals played in their respective military's developments, however the individuals most responsible for organizational innovation often receive the majority of the credit for successful technological and organizational innovations.

Perhaps this is subconscious recognition of the importance of organizational structure to military effectiveness. Especially in a top-down approach, organizational innovation is vital to the development of doctrine, strategy, tactics and technology, as shown by the Marine Corps in the interwar period. In the bottom-up approach to technological and organizational innovation, new organizations allow technology to be used in innovative manners.

These cases show that when operational innovation and technological innovation work harmoniously together, remarkable results are achieved. Blitzkrieg conquered in four weeks what Germany had failed to do for fours years during WWI. Results were seen immediately after the adoption of the Rumsfeld doctrine in Afghanistan. Innovating both technologically and operationally can bring quick results that technological innovation or organizational innovation alone cannot.

V. CONCLUSIONS

A. INTRODUCTION

Friedrich Von Bernhardi suggested that learning from past experiences was beneficial to militaries, but establishing hard and fast rules was not.[180] This begs the question: what can be learned from all of these historical examples of militaries attempting to innovate? The overarching lessons are these: technological innovation is overrated as a source of military effectiveness; organizational innovation is underrated as a source of military effectiveness; the best results stem from innovations in both organization and technology.

B. TECHNOLOGICAL INNOVATION

Technology is only as effective as the person using it. The machine gun proved its destructive power and military value during the Anglo-Zulu wars and again during WWI. However, machine guns were devastated and destroyed eight years prior to the Anglo-Zulu wars, during the Franco-Prussian War (1870- 1871). There, misdesignated as part of the artillery instead of the infantry, the machine gun failed to aid the French military efforts. The Montigny *mitrailleuse*, a crank-operated machine gun, was mounted on an artillery carriage and unveiled as the French army's secret weapon.[181] The French army then reorganized its artillery into regiments of two six-gun batteries and a third battery of ten *mitrailleuses*. LTC G.S. Hutchinson, Royal Army, claimed that "the organization of the *mitrailleuses* was equivalent to a reduction of the French Artillery by one third".[182] At the battles of Wissembourg (4 August 1870) and Spicheren (6 August 1870), the *mitrailleuses* were destroyed by Prussian artillery before they had a chance to

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[180] Friedrich von Bernhardi, On War of Today (London: H. Rees, ltd, 1913) 845, 854-855. This is inferred from Von Bernhardi's criticism of Jomini's distillant of Napoleon's doctrine and strategy into rules, complete with diagrams and strategy and his praise of Moltke's interpretations of the value historical study.

[181] John Ellis, The Social History of the Machine Gun (New York: Pantheon Books, 1975) 63-64. Though the French army touted the mitrailleuse as its secret weapon, foreign observers had watched the French development of the weapon and published several articles about it in foreign publications. Thus, the unveiling of the mitrailleuse was closely watched.

[182] LtCol G.S. Hutchinson, Royal Army, Machine-Guns: their History and Tactical Employment (London, Macmillan, 1938) 47.

fire, due to their limited range. The machine gun was also falsely identified as an artillery piece during the American Civil War. There, the machine gun was primarily used to guard bridges and other strategic points far from the primary battlefields. This was also partially due to commanding officers' lack of familiarity with the weapon.[183] The example of the French army shows that technological innovation can encourage detrimental organizational innovation, which contributed to the French loss during the Franco-Prussian War.

A military's ability to establish power in an area of operations increases over time and decreases over space, but the amount of power projected can be affected by the introduction of new technologies. It is important to realize what aspect of this time-space-power continuum new technologies will affect. It is a common mistake to misidentify the nature of a new technology. For example, the French saw the tank only as a weapon during the interwar period of the 1920's and 1930's, as opposed to a new form of transportation of weapons. Therefore, the French army strove to create tanks with heavy guns and armor.[184] The Germans, however, saw the tank as both a weapon and a new mobile platform and strove to design tanks that were quick, maneuverable and had great range.[185] The result of the conflict between the two armies is well known.

New technology alone can only incrementally improve performance on the battlefield, by creating a weapon that shoots farther, flies faster or has more armament. However, the second chapter showed that new information technology is often useless without a new organization that allows it to be used to its fullest potential. Colonel John Boyd USAF lectured about the decision-making loop which eventually became the "OODA Loop". He claimed that "operating at a faster tempo or rhythm than adversaries" would make the faster force "appear ambiguous and thereby generate confusion and disorder among adversaries".[186] He then examined historical examples from the days of antiquity, Napoleonic wars, German blitzkrieg and modern guerrilla campaigns to illustrate his point. If one's decision-making loop could operate more quickly and

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[183] Ellis, 51.

[184] Robert Doughty, The Seeds of Disaster (Hamden, Connecticut: Archon books, 1985) 142.

[185] R. H. S. Stolfi, "Equipment for Victory in France in 1940," History Vol. 55, No. 183, 14 and James Corum, The Roots of Blitzkrieg (Lawrence, Kansas: University Press of Kansas, 1992) 125.

[186] John Boyd, "Patterns of Conflict" http://www.d-n-i.net (25 May 2002) 7. OODA stands for observe, orient, decide and act.

efficiently than the opponent's then the opponent would be overwhelmed because of his inability to keep pace with latest developments in the conflict.[187] If the organization only requires a certain level of information before acting, new information and communication abilities will either be ignored or slow down the decision-making process by contributing to information overload. By coupling a communication and sensing technology with an incompatible organization, one is either slowing down the decision making cycle by overloading the organization or wasting time and money on an unused technology. In a similar vein, new communication and sensing technology is most likely to illuminate the need for and allow new organizational systems to develop. According to Boyd, by having a faster decision making process than the enemy, one could gain a distinct advantage that could overcome several other weaknesses, such as a smaller number of forces.[188]

This faster decision-making loop could be one reason that networked terrorist organizations have been so successful recently. By allowing multiple simultaneous decision cycles at once, the enemy is overwhelmed. The point is this: if advanced technology is not necessary to the mission or how the organization operates, it often becomes a liability. For example, Force XXI brought two complete command and control systems with them during their first battle experiments. Setting up the redundant system became a liability as more troops were needed to maintain the system and negated the stated goal of creating a "smaller footprint". Troops needed to carry more equipment to operate both command and control systems, as opposed to the stated goal of being lighter and more mobile. The Royal Navy's organization with respect to the organization of operational fleets had changed little since the Battle of Trafalgar when it met the German navy at the Battle of Jutland 111 years later. They ignored their new communications capability because it did not fit their current organization and therefore suffered some damage that could have been avoided with the organizational changes necessary to encourage the use of the radio.

A concern that many militaries overlook is that technology is easy to copy. Many militaries take the approach of "late modernization," where another military's technology

[187] Boyd, 9.

[188] Boyd, 30.

is copied and improved upon once the public is made aware of it.[189] This saves the late modernizing nation much of the research and development cost and allows them to profit from the mistakes made by other militaries. For example, some of the American technology used during the island-hopping campaigns of WWII was initially copied from Japanese naval designs.[190] Once technology has been copied, it is often employed to negate the advantage that new technology originally presented to the innovative combatant and simply creates a war of attrition. The German use of chemicals during WWI is an example of this. Once the French and British began to use chemical weapons in the same manner as the German army, the benefit to the Germans of employing their new weapon diminished greatly. The main result of chemical warfare was the increase in horrific casualties and its non-use in WWII.

It is never a wise strategy to employ new technology assuming that the enemy will never be able to attain the technologically advanced weapon. He usually does so, if he has enough time. Even the Zulu tribesmen during the Anglo-Zulu wars managed to capture a few machine guns. The majority of the impoverished Boer Commandos' arsenal and ammunition was gleaned from British soldiers. Nuclear weapons have found their way into the arsenals of impoverished nations and possibly into the hands of terrorist organizations.[191] Relying solely on technological innovation makes a very short development and production cycle necessary if one wants to maintain an advantage of any sort; in other words, it creates an arms race. Arms racing becomes difficult to sustain as nations resources are spent supporting the war effort in other manners.

The argument that militaries will adapt to and cope with new technology can be extended to military doctrine, operations and tactics as well. However, a well-designed military organization will allow much innovation, both in operations and tactics as well as in technology. Continual innovation is what is necessary to stay inside an opponent's OODA loop.

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[189] Alexander Gerschenkron, Economic Backwardness in Historical Perspective (Cambridge, Massachusetts: Belknap Press, 1962) 9-10.

[190] Allan Millet and Murray Williamson, Military Innovation in the Interwar Period (Cambridge: Cambridge University Press, 1996) 81.

[191] Steve Bowman, "Weapons of Mass Destruction: the Terrorist Threat", Congressional Research Service 07 March 2002. The author states that Al-Qaeda has been actively seeking nuclear capabilities.

C. ORGANIZATIONAL INNOVATION

It is characteristic of the nature of newsworthy events that the introduction of the Stealth bomber and Tomahawk missiles receive so much more public attention than the Goldwater-Nichols Act that allowed these weapons to be used more effectively by the American military. According to James R. Locher III, the American military encourages a bottom-up mentality, and often focuses on and is more receptive to technological innovation than organizational innovation.[192] However in this thesis, of the two case studies concerning the American military in the chapter on both technological and organizational innovation, both approaches towards innovation were utilized. Nevertheless, technological innovation is easier to understand, visualize and market than organizational innovation. One possible cause of the resistance to organizational innovation could be the poor definition of organizational innovation; the term is applied to every change in the status quo, including "new cafeteria food," as Joyce Wycoff sarcastically comments.[193] Perhaps the military is an environment that is resistant to change, as many critics such as Anthony C. E. Quainton and James Adams charge.[194] Richard Foster and Sarah Kaplan claim that senior leaders often have emotional attachments to projects and programs that they created or that allowed them to excel and are reluctant to see them go.[195] It is natural that stakeholders should be somewhat attached to pet projects and programs.

The solution is not to criticize the leadership and label them dinosaurs or retrograde thinkers. The solution is to foster an environment where others are encouraged to pursue and develop ideas. The French military command during the interwar period of the 1920's and 1930's was notoriously bad at this. Charles de Gaulle had to seek protection from a senior officer to salvage his career after publishing a book

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[192] James R. Locher III, address, Naval Postgraduate School, 28 May 2002.

[193] Joyce Wycoff, "Defining Innovation," On Business 1 January 2001 http://www.onbusiness.net/articles_html/JoyceWycoff_224.html (25 May 2002).

[194] James Adams, The Next World War (New York: Simon and Schuster, 1998) 312-313 and Anthony C. E. Quainton "Creating Change Insurgents at State" Information Impacts Magazine July 2001. Adams claims there is wide gulf in today's military between younger officers who recognize the power of new information technologies and the established bureaucracies. Quainton claims that institutions such as the military and the foreign service encourage conformity and that innovative thinking happens mostly at high (political appointee) and low (junior officer) levels.

[195] Richard Foster and Sarah Kaplan, Creative Destruction (New York: Doubleday & Company, Inc, 2001) 62.

that outlined his ideas for an armored division and cast doubt onto the wisdom of the French doctrine a the time. However, the German military encouraged unconventional thinkers such as "Hammerin' Heinz" Guderian even if said thinkers clashed with conventional authority.[196]

When writing about military effectiveness and about dramatic battles, more focus is placed on tactics and operations than on the organizational changes that allowed these new tactics and operations to be fully developed. However, behind every major tactical and operational change was a dramatic organizational change: either a turn-over of leadership, a new branch forming, division or subdivision of current military structures or the recognition of a new role for a certain branch of the military.

Organizational innovation allows new thinkers to rise to the top and establish the basis for new doctrine, operations and tactics—the foundations of a successful operational military. Organizational innovation is remarkably underrated as a tool for military effectiveness. Most militaries seem forced into organizational innovation by the desperation of their situations or lack of funding for technological innovation to conventionally oppose their adversaries. Mao Zedong advocated the people's war only until he had enough political, military and financial force to create a standing army and force a decisive battle with the then Chinese government. He wanted to reject his own organizational innovation that had proven to be successful and adopt a more conventional organization when the Red Army had enough power to do so.[197]

This unfortunate trend of organizational innovators desiring to adopt more conventional organizational structures ignores the fact that most purely organizational innovations have been rather successful, or more successful than most purely technological innovations. Perhaps this resistance to organizational innovation occurs precisely because most purely organizational innovations have been forced upon militaries: change or suffer unacceptable consequences. For example, only when Great Britain was in danger of starving due to U-boat activity during WWI was the Admiralty forced to reorganize itself and accept convoying. The Boer Commandoes had little

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196 Barry Posen, The Sources of Military Doctrine (Ithaca, New York: Cornell University Press, 1984) 208-210.

197 Mao Zedong, "Strategy in China's Revolutionary War" Selected Writings of Mao Tse-tung (Beijing: Foreign Languages Press, 1963) 985.

choice in their new organization after their conventional military leadership surrendered to the British in the Boer War. Since the former organization allowed the situation to deteriorate to such dire circumstances, almost any change is positive. However, poorly advised changes, such as the French artillery during the Franco-Prussian War, can have catastrophic effects on a military.

The lesson to be learned is that organizational innovation can be remarkably successful and allow for many new ideas: both technological and operational. It should be encouraged, as opposed to something that is fiercely resisted.

D. ORGANIZATIONAL AND TECHNOLOGICAL INNOVATION

The combination of organizational and technological innovation can be the most effective form of innovation there is. By surprising the opponent with both new technology and new organization, the opponent will become disoriented and will suffer considerable damage reacting to the new and unexpected change in his opponent. By massive innovation, one can create the shorter decision loop advocated by John Boyd.

By opting for both untested organization and technology, a military is risking quite a lot. The torpedo boats of the French Jeune École were an embarrassment to the French navy when it was discovered that the boats had incredibly limited ranges. Much less could they sneak up undetected and destroy much larger battleships. However, the new German armored divisions combined with Panzers created an incredibly successful campaign for the German military in the beginning of WWII. Opposing militaries felt overwhelmed by the perceived technological superiority of the German army, when in fact there existed only 10 Panzer divisions. This thin modernization became transparent as the German armies lost more tanks over the course of the war than could be replaced and German forces found themselves overextended. However, the German army's risky innovations created remarkable dividends in their invasion of Belgium, France and the Netherlands.

Allan Millett, Williamson Murray and Kenneth Watman pose several questions in determining military effectiveness, which include: "to what degree are the military's strategic objectives consistent with their … technical base" and "to what extent are a military organization's operational concepts and decisions consistent with available

technology".[198] They are emphasizing that militaries must have compatible technological and organizational systems. If the weapon systems developed and acquired by a military cannot be effectively used by the current organization, then the military will not reach its full potential. Likewise, if the organization creates the need for weapons that are not available, it too, is doomed to failure. This could be why the Jeune École failed: their concept of operations required technology that was not feasible or available at the time it was tried. By simplifying and ignoring the importance that advanced technology was to play in their new organization, the vision of a smaller, more agile navy was doomed. Granted, technology and organization do not always advance at the exactly the same rate, and simultaneously developing the two is an elusive goal. However, an attainable goal is for new technology and new organization to be developed with consideration towards each other.

Sometimes militaries advance technologically first, creating new technology and then considering new ways of employing the technology: new tactics, new operations and new strategy. Eventually new technology via the new strategy creates a demand for organizational innovation to become fully effective. This bottom-up approach is popular in many militaries. For example, at the Battle of Jutland, radio was available on board vessels. However, the torpedomen (electricians) and not the signalmen were responsible for radio operations and even officers specializing in signaling were not trained in use of the radio.[199] Because of this, radio use was sporadic at best and largely ineffective. Eventually the organization caught up with the new technology to employ the radio more effectively in future wars. One example of a military successfully innovating technologically and then organizationally is the German U-boats during WWII. The U-boats were designed and developed during the interwar period, and then wolf-pack organization and tactics were experimented with in the first year of the submarine

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[198] Allan R. Millett and Williamson Murray, ed., Military Effectiveness (Boston : Unwin Hyman, 1988) 9-15.

[199] Andrew Gordon, The Rules of the Game: Jutland and the British Naval Command (London: John Murray Publishers, Ltd., 1996) 363.

campaign. Admiral Dönitz eventually consolidated the U-boat command into a centralized organization, with U-boats controlled from headquarters in Lorient.[200]

At other times, organizational innovation comes first, and technology is required to follow. The Marine Corps amphibious doctrine is a successful example of this. Marine Corps leadership had recognized the need for an amphibious capability in the early 1920's and established the Fleet Marine Force to focus on the development of the doctrine, organization and tactics. It could be said that the development of amphibious doctrine was a top-down approach towards technological and organizational innovation. First the need for the amphibious capability was recognized, and then the organization reshaped itself to allow for doctrinal development. The numerous amphibious and fleet experiments allowed for operational and tactical development. As war broke out across Europe, everything except the technology was in place for the new amphibious capabilities. The maturation of embryonic landing craft, amphibious tanks (LUTS) and LSDs occupied the early war years.[201] Much of the success of the island-hopping campaign is due to the fact that all aspects, both organizational and technological fell into place just before the new amphibious capability was used for the first time.

A far less successful example of this method of organizational and technological innovation was the French Jeune École. Admiral Aube recognized a need to efficiently deal with the threat posed by the British Navy. When he came to power, he effected organizational changes, ridding the French navy of its most senior leadership and trying to promote a class of younger, sea-going officers, as opposed to the current environment of senior leadership based on politics as opposed to war-fighting experience. He then developed doctrine and operations for his fleet of torpedo boats and gunboats. However, technology did not keep pace. The necessary research and development of the vessels was never undertaken and the vessels were built "on the cheap", which comprised the vessels even more than the simple lack of research and development. The ultimate result was a fleet of unseaworthy vessels and an embarrassment to the French navy. Also, he attempt at organizational innovation was half-hearted. While he replaced much of the

[200]Roland Bowling, CAPT USN (Ret), "The Negative Influence of Mahan on the Protection of Shipping in Wartime," Diss. University of Maine, 1980: 369.

[201] Kenneth Clifford COL USMCR, Amphibious Warfare Development in Britain and America from 1920-1940. (Laurens, New York: Edgewood, Inc, 1983) 111-118.

leaderships, the new leaders filled the same roles as before. There was no drastically new organizational structure that could foster the developments of Jeune École doctrine and technology. Both technology and organization failed the Jeune École.

E. FINAL THOUGHTS

The lesson to be learned from this thesis is that there is no ultimate weapon or ultimate organization that will successfully respond to every threat in the future. Organizations and technology have to be continually reshaped to meet the new threats as the future unfolds. No new technology or organization will ever be the last weapon needed or the last organizational change made. It was once claimed that the invention of nuclear weapons had obviated the need for any new military technological innovation. However, militaries have evolved and developed new technologies since.

Once this is acknowledged, one can recognize that constant innovation, both technological and organizational, is required. Militaries seeking innovation should not invest solely in technology, as this approach has been historically disappointing. While organizational innovation has been more successful, it is often resisted by militaries themselves. The most effective innovations are where technology and organization work in tandem. Sometimes technology will unveil the need for new organization and other times new organizations will allow the development of new technology. Each form of innovation should fuel the other, allowing militaries to advance and adapt to the times and to reach their full potential. A symbiosis, not stasis, is the key to victory.

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